KLAMATH RIVER FISHERIES ASSESSMENT PROGRAM

Annual Report 1988

August 1989

Fisheries Assistance Office
Arcata California
Western Region

ANNUAL REPORT

KLAMATH RIVER FISHERIES ASSESSMENT PROGRAM

1988

U.S. Fish and Wildlife Service
Fisheries Assistance Office
Arcata, California

REPORT NO. AFF/FAO-89-13

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August 1989

DISCLAIMER

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LIST OF ACRONYMNS AND ABBREVIATIONS

ad-clip	- Adipose fin-clip
CDFG	- California Department of Fish and Game
cm	- Centimeters
CWT	- Coded Wire Tag
DOI	- U.S. Department of the Interior
FAO - Arcata	- Fisheries Assistance Office, Arcata, California
FWS	- U.S. Fish and Wildlife Service
HVR	- Hoopa Valley Indian Reservation
IGH	- Iron Gate Hatchery
kg	- Kilograms
km	- Kilometers
KRFMC	- Klamath River Fishery Management Council
KRSMG	- Klamath River Salmon Management Group
mm	- Millimeters
n	- Sample size
PFMC	- Pacific Fishery Management Council
s	- Standard deviation
TRH	- Trinity River Hatchery
USFS	- U.S. Forest Service

ACKNOWLEDGEMENTS

The authors wish to express their appreciation to the following persons whose efforts were invaluable in the completion of 1987 field studies and preparation of this report:

-- Debra A. Becker for administrative support, editorial assistance, patience and diligence in word processing and related matters;

-- Other members of the Arcata-FAO field staff:

Greg Bryant	Karl Johnson
Richard Burrows	Donald Kenta (NCIDC)
Willard Carlson	Shawn Logan (NCIDC)
Jeff Chan	Wendy Markl
David Cook	Dana Olsen
Jim Craig	Eli Ricca (YCC)
Frank Erickson	Tom Sak
John Frederick	Gary Stern
Nancy Giffin	Larry Tisue (Volunteer)
Greg Goldsmith	Margaret Webster
Lorita James	Dave Wills

-- Indian fishers of the Hoopa Valley Reservation for their hospitality and cooperation in data collection efforts.

-- Northern California Indian Development Council for assistance and cooperation during 1988.

Acknowledgement is extended to the Youth Conservation Corps for the valuable manpower and support provided during the past season; and personnel of the California Department of Fish and Game for providing data, advice, access to various equipment and invitations to observe and participate in field projects.

Further acknowledgement is extended to members of the Fisheries Department of the Hoopa Valley Business Council for their assistance, coordination and cooperation in fisheries field programs.

Final acknowledgement is extended to the Bureau of Indian Affairs for funding the Fisheries Assessment Program, and to the many Bureau personnel who have cooperated with FAO-Arcata staff during the past season.

ANNUAL REPORT

KLAMATH RIVER FISHERIES INVESTIGATION PROGRAM

1988

FORWARD

The Klamath River watershed drains approximately 14,400 km^2 in Oregon and 26,000 km^2 in California. The majority of the watershed in California is within the boundaries of the Six Rivers, Klamath and Shasta-Trinity National Forests. The Hoopa Valley Indian Reservation, comprising approximately 583 km^2 in Humboldt and Del Norte counties, borders the lower 68 km of the Klamath River and lower 26 km of the Trinity River, the largest tributary in the drainage (Figure 1). The most important anadromous salmonid spawning tributaries in the basin include the Trinity River, draining approximately 7,690 km^2, and the Shasta, Scott and Salmon Rivers, each draining approximately 2,070 km^2. Iron Gate Dam on the Klamath River (river km 306) and Lewiston Dam on the Trinity River (river km 249) represent the upper limits of anadromous salmonid migration in the basin. Iron Gate and Trinity River Hatcheries located near the base of each dam, were constructed as mitigation for natural fish production losses resulting from each project.

The Klamath River Basin has historically supported large runs of chinook salmon (Oncorhynchus tshawytscha) and steelhead trout (O. mykiss), which have contributed considerably to subsistence, sport and commercial fisheries in California. Generations of Indians have utilized fishing grounds in the drainage, and their fisheries for salmon, steelhead and sturgeon have historically provided the mainstay of Indian economy in the area. Sport fishing for salmon and steelhead in the drainage may exceed 200,000 angler days annually. In addition Klamath River stocks account for up to 30% of commercial chinook salmon landings in northern California and southern Oregon and have averaged approximately 450,000 chinook per year over the last decade. The U.S. Forest Service (USFS) estimated an annual net economic value of salmon and steelhead fisheries attributable to USFS lands in the Klamath River Basin in excess of $20 million and mean annual net economic values per kilometer of chinook salmon, coho salmon (O. kisutch), and steelhead trout habitat in the basin of $15,600, $1,400 and $2,800, respectively (USFS 1977, USFS 1978). In 1980, the Department of the Interior included the Klamath and Trinity Rivers in the National Wild and Scenic Rivers System. Portions of the Klamath and Trinity Rivers are also under California state classification as Wild and Scenic Rivers.

Concern about the depletion of anadromous salmonid resources and associated habitat in the basin emerged around the turn of the century, and has accelerated in recent decades coincident with expanded logging and fishing operations, dam building activity, road construction and other development. As in other river systems of the Pacific Northwest, chinook salmon of the Klamath River Basin have experienced the continued effects of habitat degradation and over-exploitation as reflected by declining runs in recent decades.

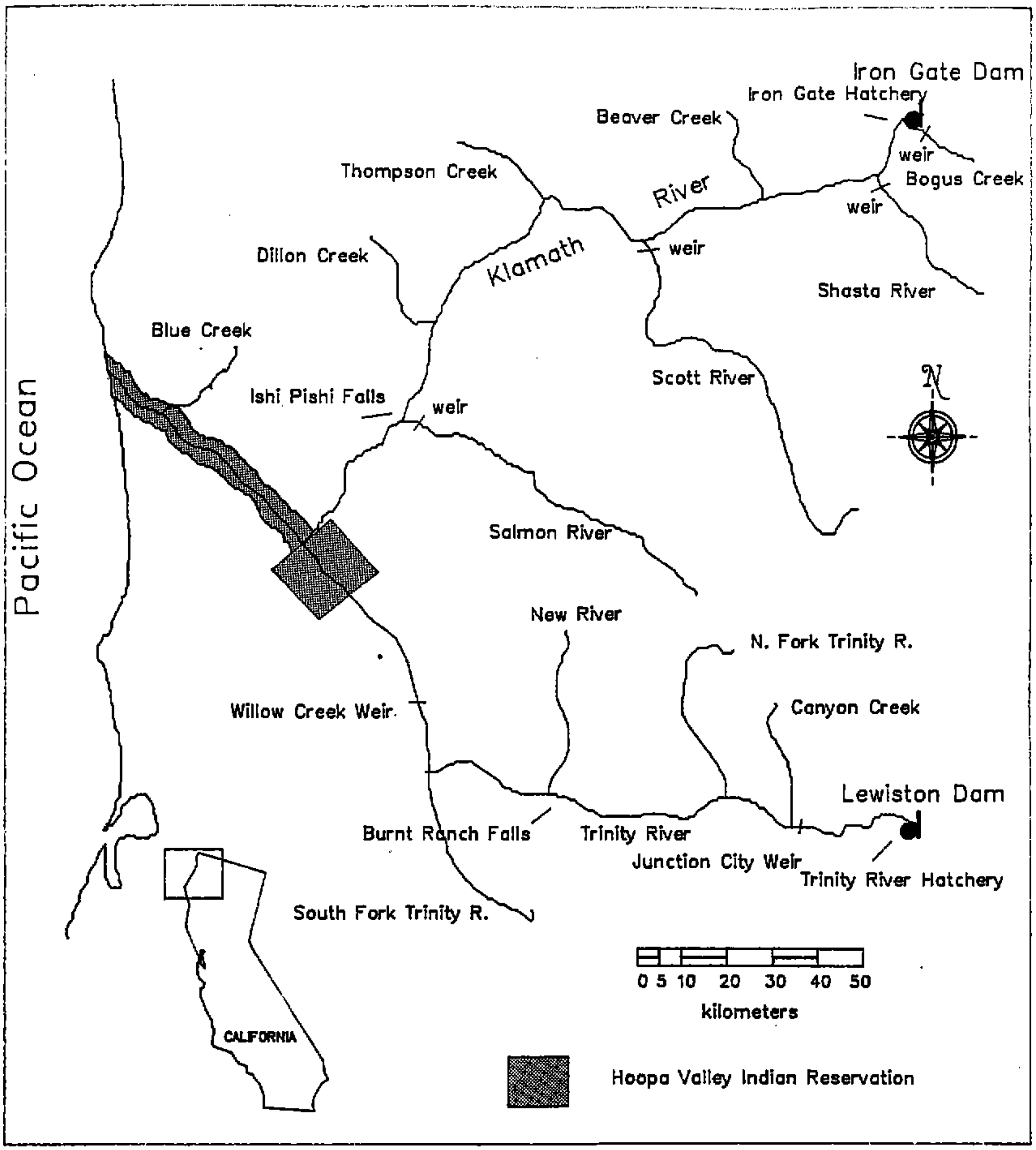

Figure 1. Overview map of the Klamath-Trinity River basin accessable to anadromous fish.

In response to habitat problems resulting from the Trinity River Division project, the Congress enacted P.L. 98-541, the Trinity River Basin Fish and Wildlife Management Program on October 24, 1984. This action directs the Secretary of the Interior to restore fish and wildlife populations in the Trinity Basin to levels approximating those which existed immediately before the start of construction on that project. An office administered jointly by the U.S. Bureau of Reclamation and the U.S. Fish and Wildlife Service was recently opened to oversee work under P.L. 98-541.

In 1985 CH_2M Hill, a consulting firm, completed a document entitled "Klamath River Basin Fisheries Resource Plan", through contract with the Department of the Interior, Bureau of Indian Affairs (DOI 1985). This plan details restoration actions for the remainder of the Klamath Basin which are similar to those included in the Trinity River Basin Fish and Wildlife Management Program described above.

Since passage of the Magnuson Fishery Conservation Management Act of 1976 (16 U.S.C. 1801-1882) and the promulgation of the first set of Federal fishing regulations governing Indian fishing on the Hoopa Valley Reservation (HVR) in 1977, considerable attention has also focused on the fisheries operating on the depressed chinook salmon runs, notably the ocean troll fisheries and the Indian gill net fishery on the Klamath and Trinity Rivers. In 1985, the Klamath River Salmon Management Group (KRSMG) was formed to provide recommendations for the management of the combined fisheries operating on Klamath River chinook stocks. In 1986, the KRSMG provided recommendations concerning allowable levels of harvest for all Klamath stock fisheries.

On October 27, 1986 the Congress enacted P.L. 99-552, the Klamath River Fish and Wildlife Restoration Act. This action authorized the Secretary of the Interior to restore the anadromous fish populations to optimum levels in both the Klamath and Trinity Rivers through a habitat restoration program and formation of the Klamath River Fishery Management Council (KRSMC) which replaced the KRSMG.

The Assistant Secretaries of Indian Affairs and Fish and Wildlife and Parks, in addressing Departmental resource and Indian Trust responsibilities concerning the Klamath River Basin resource and HVR, have entered into annual fiscal Interagency Agreements providing for fisheries investigation programs focusing on the monitoring and evaluation of chinook salmon runs in the Klamath River, and the monitoring of Indian net harvest levels on the HVR. This is the tenth in a series of annual reports covering the Klamath River Fisheries Assessment Program, conducted through FAO-Arcata under the Fiscal Year 1988 Interagency Agreement.

The program consists of three major groupings of related activities:

(1) Beach Seining Operations focus on:

(a) the provision of age composition data required to forecast annual Klamath River chinook ocean population abundance; and

(b) the annual monitoring of fall chinook runs to evaluate natural/hatchery composition, to assess hook scarring and gill net marking incidences, to collect age-growth, length frequency and length-weight data and to provide information on run timing and migration patterns.

(2) Harvest Monitoring and Evaluation Efforts focus on:

(a) the annual estimation of the Indian net harvest levels on the HVR involving chinook salmon (spring and fall runs), steelhead trout (fall run), coho salmon, and green sturgeon (*Acipenser medirostris*);

(b) the collection and reading of coded-wire tags recovered from the net fishery during harvest monitoring activities and use of this data in statistical evaluation of the various tagged release groups through their occurrence in the ocean and in-river net fisheries; and

(c) the annual monitoring of chinook and coho salmon, steelhead trout and green sturgeon runs to evaluate natural/hatchery composition, to assess length frequency, age-growth and length-weight relationships within the harvest.

(3) Technical Assistance involves:

(a) participation in various technical committees including the Department of Interior technical team and the Technical Advisory Team to the KRFMC;

(b) the provision of general technical assistance, as requested, to the California Department of Fish and Game (CDFG), Bureau of Indian Affairs (BIA), Hoopa Valley Business Council (HVBC) Fisheries Department, other branches of the FWS and various other groups and agencies; and

(c) the conduct of various other field studies in the Klamath River Basin as is deemed appropriate.

Methods utilized and results obtained during 1988 through these program activities are detailed in sections summarizing data collected on chinook salmon, coho salmon, steelhead trout, sturgeon and shad. During 1983 the HVBC Fisheries Department assumed responsibility for harvest monitoring programs covering the Trinity River portion of the HVR, formerly a part of FAO-Arcata responsibilities. This responsibility remained with the Hoopa Tribe during 1988. It should, therefore, be realized that harvest data presented in this report, unless otherwise noted, are not strictly comparable with harvest data presented in certain previous reports since the area of coverage has changed as described.

KLAMATH RIVER FISHERIES ASSESSMENT PROGRAM

ABSTRACT

During the fall run sampling period, 3,294 chinook salmon (Oncorhynchus tshawytscha) were captured in 269 sets during 1988 seining operations in the Klamath River estuary in Northern California. Scales were collected from 774 chinook for age analysis. Age analysis from scale samples indicates an age composition of 6.1% 2-year-olds, 49.6% 3-year-olds, 42.4% 4-year-olds and 1.9% 5-year-olds. Spaghetti reward tags were applied to 757 chinook for mark recapture analysis. Ad-clipped chinook, containing coded wire tag (CWT) implanted primarily at the hatchery, comprised 6.5% of the sample. The Indian gill net harvest on the Klamath River portion of the Hoopa Valley Reservation (HVR) during 1988 was estimated at 46,892 fall and 2,926 spring chinook. An estimated 2,540 fall and 733 spring CWT chinook representing 46 fall and 5 spring chinook release groups were harvested in the 1988 gill net fisheries on the Klamath River portion of the Hoopa Valley Reservation.

Nineteen coho salmon (O. kisutch) were captured during seining operations in the Klamath River estuary. Ad-clipped coho containing CWT implanted at the hatchery comprised 5.9% of the sample. Based on scales collected from 17 coho, age composition of the returning coho was 100% 3-year-olds. Spaghetti reward tags were applied to 17 coho, however, none were recovered. An estimated 588 coho salmon (15 jacks and 573 adults) were harvested in the Indian gill net fishery on the Klamath portion of the HVR in 1988. Ad-clipped coho comprised 3.2% of the sampled harvest. One CWT was recovered.

Five hundred twenty steelhead trout (O. mykiss) were captured during 1988 seining operations in the Klamath River estuary. The estimated harvest of fall steelhead by the Indian gill net fishery on the Klamath River portion of the HVR was 399, including 36 half pounders.

One green sturgeon (Acipenser medirostris) and one white sturgeon (A. transmontanus) were captured during the 1988 seining operations in the Klamath River estuary. An estimated 212 green sturgeon were harvested in the Indian gill net fishery on the Klamath River portion of the HVR.

CHINOOK SALMON INVESTIGATIONS

BEACH SEINING PROGRAM

INTRODUCTION

The beach seining program was initiated by FAO-Arcata biologists in 1979 to collect biological data on Klamath River fall chinook salmon. The program also utilized catch per unit effort (C/E) and mark-recapture techniques to develop in-season and post-season run size estimates. During the 1980 season, the assumptions of the mark-recapture methodology could not be met, and the mark-recapture population estimation program was discontinued. An in-season run-size prediction model was also developed. However, C/E was influenced by environmental factors, and tended to be independent of run size strength, and therefore limited comparisons between seasons. Consequently, the program emphasis focused on collection of age composition data, run timing, hook scarring, and other basic biological data. The age composition data have aided the estimation of ocean stock size of 3- and 4-year-old Klamath River fall chinook, and consequently, the management of the ocean and in-river fisheries. The 1988 season is the tenth consecutive year of sampling fall chinook salmon near the mouth of the Klamath River.

METHODS

Beach Seining operations began on July 18, 1988, on the South Spit of the Klamath River and ended on September 22, 1988. The seining was conducted four days per week Monday, Tuesday, Thursday and Friday. The river mouth area was chosen to allow sampling of the fall chinook run prior to sustaining in-river harvest. The lower estuary was surveyed hydro-acoustically to obtain depth profiles to locate and map the channel contours (Figure 2). Since chinook salmon tend to migrate through the deeper channels of cool, highly saline water within the mouth area, a sampling site was chosen adjacent to a major channel which allowed efficient seining during most tidal stages.

The seining was conducted by a crew of eight biologists and technicians. Seining began at 0900 hrs and ended about 1330 hrs; a total of eight sets were made at half-hour intervals. A 150 m (length) by 6 m (depth) seine net (8.9 cm stretched mesh) was set from a Valco river boat and retrieved to shore using gas-powered winches.

Upon capture, chinook salmon were released or transferred into holding cages for sampling. Approximately every fourth chinook captured was retained for biological sampling; other chinook were immediately released without examination. Chinook selected for sampling were measured to the nearest centimeter forklength (fl), hole-punched in the caudal fin, tagged using spaghetti reward tags (provided to FAO-Arcata by CDFG), weighed and examined for fin-clips, hook scars, predator wounds, gill net marks and other distinguishing characters. Scales were sampled for later age analysis as described in the Age Composition Section. Examination of fish for gill net marks and hook scars is a continuing effort to document fisheries impacts on Klamath River chinook salmon populations. Physical wounds attributable to hooking incidents were classified according to criteria listed in Table 1.

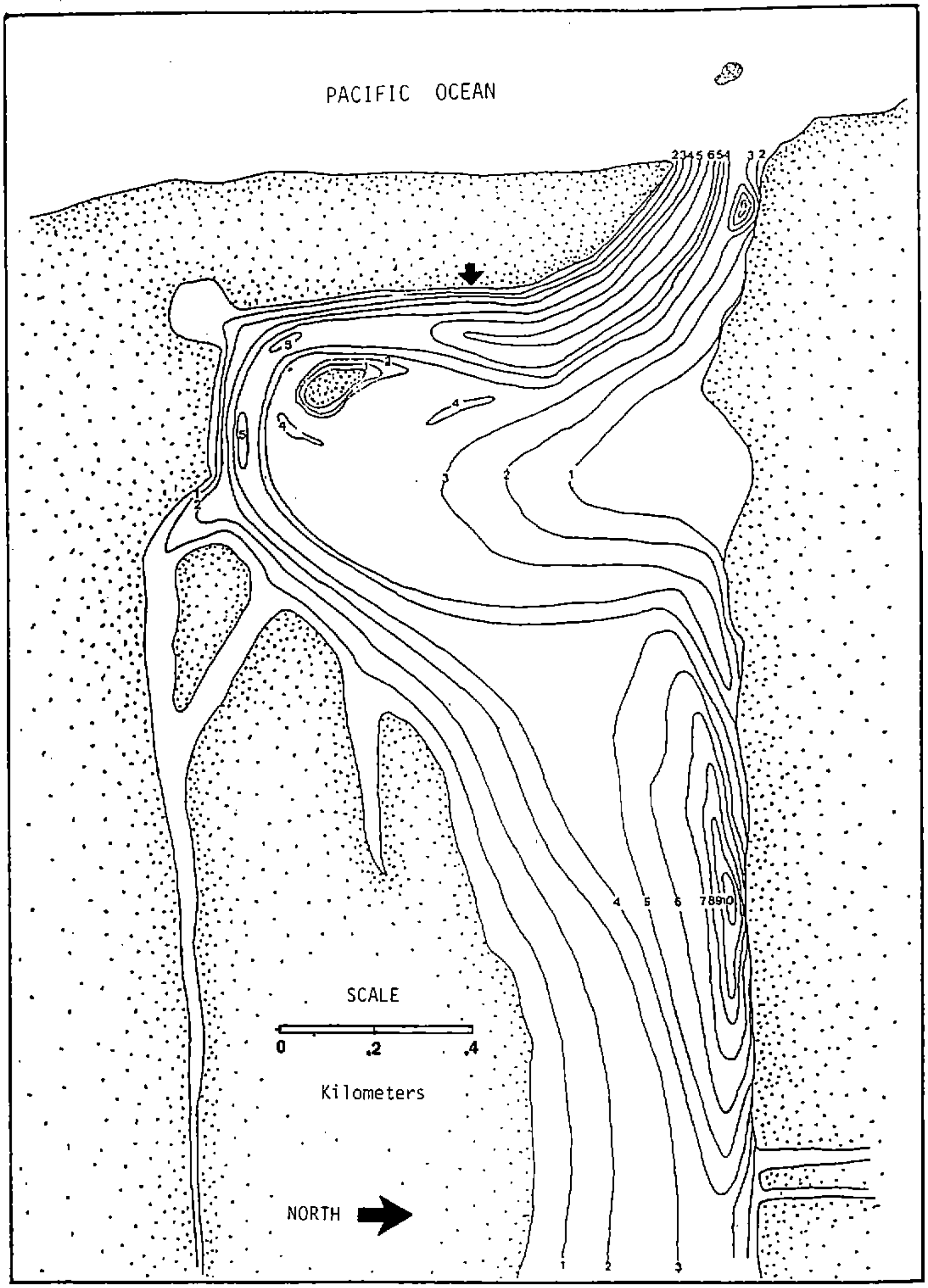

Figure 2. Depth contours of the Klamath River estuary during 1988.

TABLE 1. Categorization of hook scars observed during 1988 beach seining operations in the Klamath River estuary.

Characteristic	Classification	Criteria for Classification
Freshness	Fresh	Open wound, whether bleeding or not. No substantial healing exhibited.
	Healed	Completely healed scar, or open wound exhibiting a state of near total healing.
Severity	Minor	Obvious wound or scar, but not extensive or deep.
	Moderate	Extensive or deep wound or scar. Major vital structures intact.
	Major	Extensive or deep wound or scar. Vital structures missing or shredded. Debilitating damage (e.g. blindness).
Location	Upper Jaw	
	Lower Jaw	
	Eye and Orbit	
	Opercle	
	Isthmus	
	All Other Head Areas (Includes nose, inside mouth and top of head)	

Although the seining commenced on July 18, the 1988 fall chinook analyses were based on data collected from July 25 to September 23, 1988. Known age coded-wire tagged (CWT) chinook captured in the gill net fishery during July provided estimates of the relative stock proportion of spring and fall chinook. This CWT harvest information indicated that the chinook harvested in latter July were predominantly of fall chinook stock origin (refer to Net Harvest section).

RESULTS AND DISCUSSION

During the defined fall run sampling period (July 25 through September 22, 1988), 3,294 chinook were caught in 269 seine hauls; of which 782 were sampled. By age category, 48 were jacks (<56 cm) and 734 were adults ($\geq$56 cm). Jacks averaged 47.3 cm in length, while the mean length of adults was 73.9 cm (Figure 3). The mean length of 1988 adults was significantly larger than adults sampled in 1987 and 1986 ($p<0.05$) and was significantly smaller than adults sampled in 1985 ($p<0.05$). The mean size of 1988 jacks did not differ significantly from jacks sampled in 1987 ($p>0.05$) but were larger than 1986 jacks ($p<0.05$) and smaller than those of 1985 ($p<0.05$).

Age composition of the fall run was determined from 774 scales. Two-year-olds constituted 6.1%, three-year-olds was the largest age class (49.6%), followed by four-year-olds (42.4%). Five-year-olds (1.9%) were the smallest component. Six-year-old chinook were absent from the sample. Refer to the Age Composition section for detailed length and age statistics and maturity characteristics.

Adipose Fin-Clips

Ad-clips were observed on 51 chinook salmon (3 jacks and 48 adults), for ad-clip occurrence rates of 6.3% and 6.6%, respectively. The mean fork length of ad-clipped jacks was 48.7 cm, and 74.5 cm for ad-clipped adults (Table 2). Non-clipped jacks averaged 47.2 cm in length, while the mean for non-clipped adults was 73.8 cm. Ad-clipped jacks and adults did not differ significantly ($p>0.05$) in size from those not clipped. For analyses by individual age class, age 3 ad-clipped chinook did not differ significantly ($p>0.05$) in size from those not clipped. Age 4 ad-clipped chinook were smaller ($p<0.05$) than non-clipped fish.

Mean length of ad-clipped jacks have not differed from non-clipped jacks in the previous seven seasons. Ad-clipped adults were smaller than non-clipped adults in five of the seven former seasons; with no differences observed in 1983 and 1986.

Length-Weight Analyses

Weights were recorded from 323 chinook. Although the weights were taken opportunistically, the length-frequency distribution of the weight subsample is statistically comparable to the entire biosample of 782 chinook. The mean weight was 6.3 kg; jacks and adults averaged 2.0 kg and 7.1 kg, respectively. The smallest chinook was 0.5 kg, the largest weight 15.5 kg. The length-weight relationship was described by the equation Log(weight) = -4.337 + 2.765 Log (fork length)R-squared = 0.916 (Figure 4).

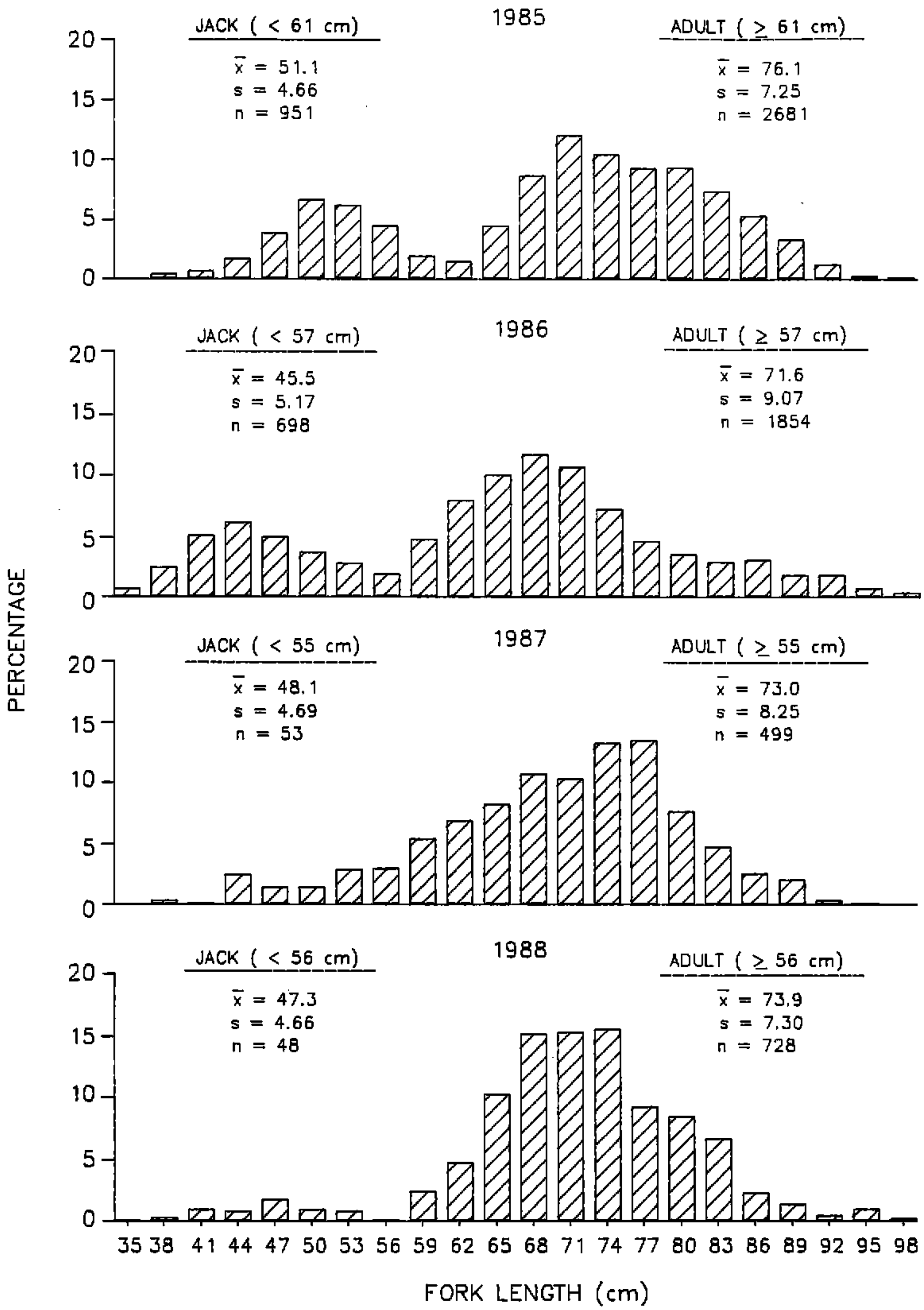

Figure 3. Length frequency distributions of chinook salmon captured during beach seining operations in the Klamath River estuary during 1985-1988.

TABLE 2. Mean length, standard deviation and sample size of fin-clipped and hook-scarred chinook captured during the 1988 beach seining operation.

	$\overline{X}$ (cm)	s	n
All Sampled			
Jacks (< 56 cm)	47.3	4.93	47
Adults ($\geq$ 56 cm)	73.9	7.35	727
Non-Clipped			
Age 2	47.3	5.07	44
Age 3	69.7	5.23	370
Age 4	78.6	6.32	292
Age 5	84.9	7.96	14
Adults	73.8	7.42	676
Ad-Clipped			
Age 2	48.7	1.53	3
Age 3	68.4	2.93	14
Age 4	76.6	5.56	36
Age 5	87.0	--	1
Adults	74.5	6.37	51
Hook-Scarred			
Age 2	52.0	2.83	4
Age 3	69.6	5.87	59
Age 4	79.2	6.85	38
Age 5	80.0	--	1
Adults	73.5	7.68	98
Non Hook-Scarred			
Age 2	46.7	4.49	43
Age 3	69.6	5.04	325
Age 4	78.2	6.19	290
Age 5	85.4	7.84	14
Adults	73.9	7.28	629

The 1988 adult chinook were significantly heavier ($p<0.05$) than last year. There was no difference ($p>0.05$) in the jacks. The mean weight of 1987 beach seine caught chinook jacks and adults was 1.8 kg and 5.9 kg, respectively. For comparison the mean weight of 177 adult chinook sampled from the 1988 estuary gill net fishery was 7.3 kg.

Gill Net Marking

Gill net markings were identified on two adult chinook (75 and 76 cm FL), for an overall incidence rate of 0.3%; none were seen on jacks. The overall incidence rates for the 1985 through 1987 seasons were: 0.4%, 1.3%, and 2.2%, respectively.

Based on previous years conclusions that the gill net mark incidence is correlated to the number of chinook landed in the gill net fishery, the 1988 gill net marking rate would be expected to be greater than 0.3%. Possible explanations for the low gill net mark incidence include below average drop out rate in the gill net fishery, above average mortality for fish that contacted a gill net yet escaped or chinook with gill net marks did not enter the beach seining area.

Hook Scarring

Of 728 chinook examined for hookscars, 102 individuals (14.0%) had one or more scars (Table 3). Scars were observed on four jacks (8.3%), and 98 adults (12.5%) (Table 2). Five fish (all adults) were double scarred and one chinook had three scars. Thus, the percentage occurrence of hook scars (Table 3) are not comparable to the catégorical frequencies in Table 4. By category, fresh scars (54.8%) were observed more frequently than healed scars (45.2%)(Table 4). Most of the scars were of the "minor" severity category; lower survival would be expected of chinook receiving scars of greater severity and would explain their scarcity in Table 4. Hook scars were equally prevalent on the upper and lower jaw. In previous years, these two locations received the majority of the scars.

The hook scar occurrence rate for 1987 was 20.1%; 18.9% on jacks and 20.2% for adults. The 1988 hook scar rates are the lowest since 1985 (Figure 5). Differences in occurrence rate among seasons may not necessarily equate to ocean sport/commercial harvest intensity levels. Chinook differ in their age at sexual maturity; therefore, ocean residence may vary from one to several years (hence, increased probability of being hook scarred). The offshore distribution of chinook stocks are not constant and harvest quotas vary annually. In addition, "fresh" category scars may have been sustained offshore or in the Klamath River estuary sport fishery.

Mean fork length of non-hook scarred was 46.9 cm for Jacks and 73.9 cm for adults. Hook scarred jacks averaged 52.0 cm in length, whereas the mean of scarred adults was 73.5 cm. Comparison of mean lengths by age did not reveal any differences between hook scarred and non-hook scarred adults. Only the hook scarred jacks were significantly ($p<0.05$) different in size, but this difference may be related to sample size (Table 2). In most prior seasons, scarred jacks have been larger than those not scarred, except in 1983 and 1987, when size did not differ. Selective mortality of smaller hook scarred jacks (whereby the larger, surviving scarred jacks inflate the mean length) is one possible explanation for differences in size.

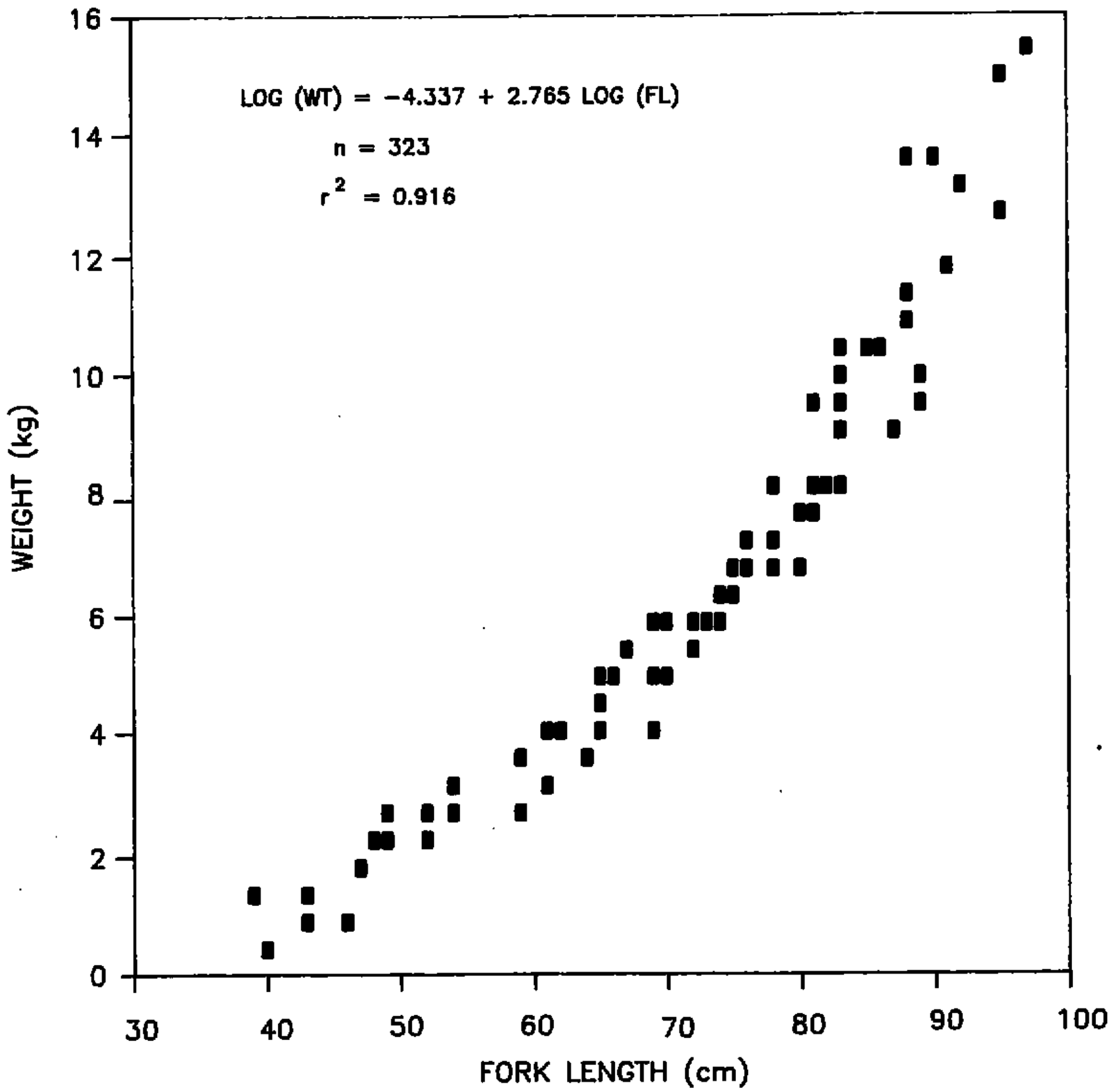

Figure 4. Length-weight relationship of chinook salmon captured during 1988 beach seining operations in the Klamath River estuary.

TABLE 3. Percentage occurrence of 102 hook scars observed on 776 Klamath River fall chinook salmon sampled during the 1988 beach seining operations.

Type of Scar	RUN COMPONENT		
	Jack	Adult	All Chinook
Single Hook Scar1/	8.3	13.5	13.2
Two Hook Scars2/	0.0	0.7	0.7
Three Hook Scars	0.0	0.1	0.1
Fresh Hook Scar	4.2	7.9	7.6
Healed Hook Scar	4.2	6.5	6.3
Minor Hook Scar	6.3	10.2	10.0
Moderate-Major Hook Scars	2.1	4.1	4.0

1/ All fish exhibiting one or more hook scars included in this category.

2/ All fish exhibiting two or more hook scars caused by separate hooking incidents included in this category.

TABLE 4. Categorical frequencies of 104 hook scars observed from a total sample of 776 Klamath River fall chinook during 1988 beach seining operations.

Location	Stage	SEVERITY Minor (%)	Moderate (%)	Major (%)	Total (%)
Upper Jaw	Fresh	16.3	8.7	0.0	25.0
	Healed	15.4	0.9	1.0	17.3
	Total	31.7	9.6	1.0	42.3
Lower Jaw	Fresh	18.3	3.8	0.0	22.1
	Healed	13.4	7.7	0.0	21.1
	Total	31.7	11.5	0.0	43.2
Eye and Proximity	Fresh	1.9	1.9	0.0	3.8
	Healed	1.0	2.9	0.0	3.9
	Total	2.9	4.8	0.0	7.7
Opercle	Fresh	0.0	1.0	0.0	1.0
	Healed	0.0	0.0	0.0	0.0
	Total	0.0	1.0	0.0	1.0
Isthmus and Proximity	Fresh	2.9	0.0	0.0	2.9
	Healed	1.9	1.0	0.0	2.9
	Total	4.8	1.0	0.0	5.8
Other Head Areas	Fresh	0.0	0.0	0.0	0.0
	Healed	0.0	0.0	0.0	0.0
	Total	0.0	0.0	0.0	0.0
All Head Areas Combined	Fresh	39.4	15.4	0.0	54.8
	Healed	31.7	12.5	1.0	45.2
	Total	71.1	27.9	1.0	100.0

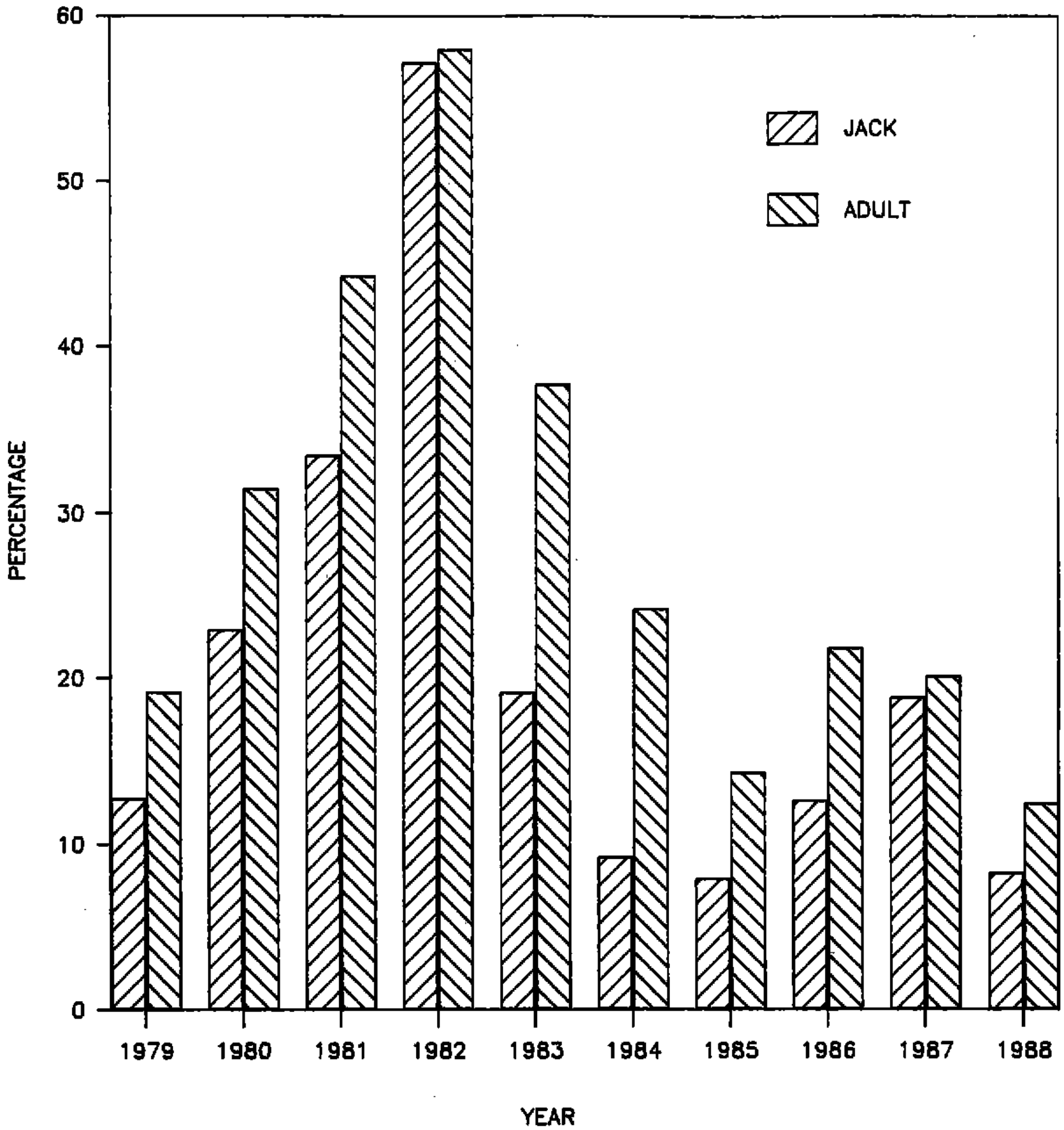

Figure 5. Hook scarring rates observed on jack and adult chinook salmon during 1979-1988 beach seining operations in the Klamath River estuary.

Size of hook scarred and non-scarred adults have not differed in 1980 to 1981, 1983 to 1984, and 1987 to 1988; while hook scarred adults were smaller in 1979, 1982, and 1986 seasons. In 1985, hook scarred adults were larger than their non-scarred counterparts. These findings are open to varying interpretations; explanations are wanting for why growth is affected in some years and not in other years. During 1985, the larger (pre-El Nino, see 1985 Annual Report) 4- and 5-year-old hook scarred chinook inflated in mean length of all hook scarred fish.

Mark-Recapture

Of 757 chinook spaghetti tagged 205 were returned for a recovery rate of 27.6%, which was similar to the 1987 recovery rate of 28.2% (Table 5). The largest number of tag returns came from TRH (36), comprising 17.4% of all returns. The gill net fishery (30) and the Bogus Creek weir (28) recoveries represents 14.7% and 13.7%, respectively. Fourty-three tags were returned by private individuals with insufficient information to identify method of capture. These returns probably came from the in-river sport fishery and the gill net fishery.

Migration

The FWS beach seining recaptured 10 chinook during the season. Seven chinook were recaptured on the same day of tagging, while the remaining three fish were recaptured 6, 10 and 11 days at large after tagging. During the past two seasons, most of the recaptures were from the same day of tagging and the number of days at large did not exceed eleven days.

Of 205 tags recovered, only 35 tags, excluding hatchery recoveries, had adequate information to determine migration rates. The migration rates were variable, as in previous seasons, and ranged from 0.2 km/day to 10.6 km/day. The mean was 5.0 km/day. From TRH, 36 tags were recovered and the mean migration rate was 4.9 km/day which ranged from 3.0 km/day to 9.2 km/day. The mean migration time from the estuary to TRH was 54 days. For tagged chinook recovered at TRH, individuals tagged later in the seining season tended to migrate faster than those tagged earlier. Migration information was not available for IGH.

Catch Effort/Run Timing

Catch per unit effort (C/E a standard measure of sampling success is used to define the 1988 fall chinook run timing trend (Figure 6). C/E trends of previous seasons are also shown (Figure 6). Variability of factors such as tide, seining site location, river mouth morphology and run timing have not allowed reliable comparisons of C/E between seasons (see Annual Reports 1986, 1987). Accordingly, discussions of C/E are limited to the 1988 season only.

The season C/E for incoming, outgoing, high slack and low slack tidal stages were: 10.9, 13.6, 9.9, and 18.1 total chinook, respectively. Analyses of weekly C/E by tidal stage or time of day did not reveal any defineable trends; C/E levels reflected the run timing magnitude. The highest weekly C/E (35.1) was from August 29 through September 2, and the most favorable tidal stage and times were the outgoing tide (48.4) and between 0830 to 1030 hours (43.4), respectively. The highest daily C/E (56.5) was on September 1.

TABLE 5. Recovery data from fall chinook salmon tagged by the Fish and Wildlife Service on the Klamath River during 1979-1988 beach seining operations (no tags were applied in 1981).

Recovery Source[1/]	NUMBER RECOVERED 1982	1983	1984	1985	1986	1987	1988	Program Total 1979-88
USFWS Beach Seine	14	7	20	36	28	9	10	213
CDFG Beach Seine	3	-	12	5	7	4	0	46
Gill Net Fishery	46	14	31	35	8	45	30	334
Shasta River Weir	19	0	3	3	1	7	0	104
In-River Sport Fishery	13	11	7	23	13	79	23	226
Trinity River Hatchery	16	14	20	72	34	44	36	286
Iron Gate Hatchery	20	12	14	85	30	58	18	274
Bogus Creek Weir	22	1	8	21	4	48	28	132
Willow Creek Weir	8	4	11	22	8	6	3	73
Scott River Weir	8	2	2	4	2	6	2	26
Junction City Weir	0	-	4	3	2	0	5	16
South Fork Trinity Weir	-	-	1	1	0	2	0	4
North Fork Trinity Weir	1	0	0	-	-	0	-	1
Salmon River Weir	-	-	-	4	0	0	3	7
Ocean	0	0	1	0	0	0	0	2
Spawning Ground Surveys	1	0	4	5	3	8	-	53
Unknown	8	4	1	13	7	0	47	34
Totals	179	69	139	332	147	316	205	1,877
Number Tagged	1,018	588	1,007	1,746	1,475	1,119	757	11,841
Recovery Rate	0.176	0.117	0.138	0.190	0.099	0.282	0.271	0.159

[1/] Listed weirs were not in operation during years where no recovery number is presented.

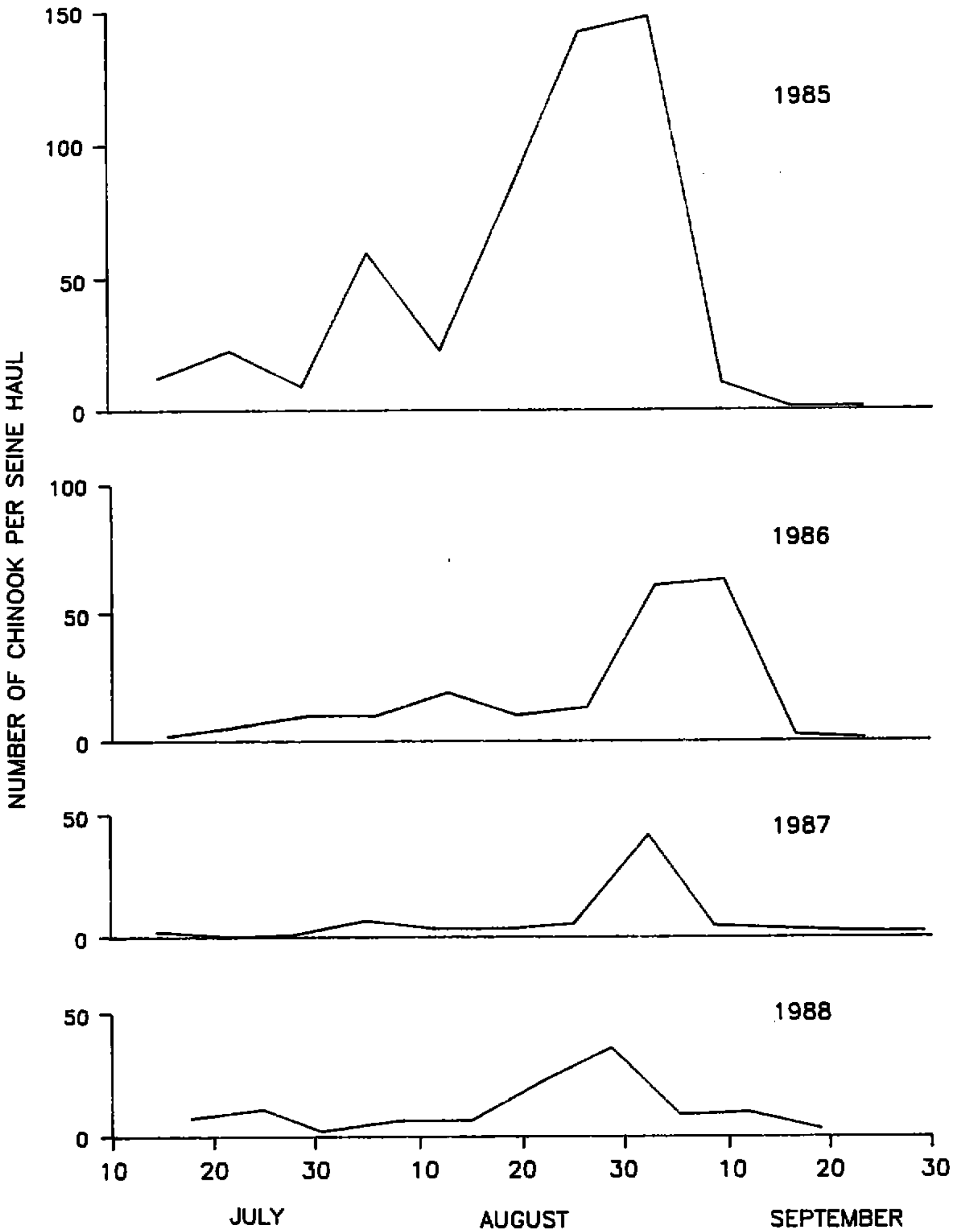

Figure 6. Weekly averages of the number of chinook salmon captured per seine haul in the Klamath River estuary during the 1985-1988 beach seining seasons.

AGE COMPOSITION

INTRODUCTION

Monitoring the age composition of a fish stock utilized by major fisheries is invaluable to resource management. Age data, in combination with length and weight measurements, provide information on stock composition, age at maturity, mortality, growth and production. Such information is useful in developing pre-season management goals and regulations. Analyses of these parameters may also be used to monitor the results and effectiveness of fishery management practices. In a continuing program to evaluate the age composition of fall chinook salmon runs in the Klamath River Basin, scales were collected through the 1988 beach seining program. A summary of age information from fall chinook runs of past seasons are also included.

METHODS

The age composition of the 1988 fall chinook run was determined through scale analysis of chinook collected during beach seining operations between July 25 and September 22, 1988 (see Beach Seining Program for details).

Impressions of scales were made on cellulose acetate using a hydraulic press equipped with variable temperature heating elements. The scale impressions were viewed on a microfiche reader. Impressions were analysed independently by two biologists, with a third reading by an additional biologist when the initial two readings differed. Scales not aged with confidence after the final reading were excluded from the age analyses. Scales from known age chinook (CWT) recovered from the Klamath River estuary were initially used to assist in the age interpretation.

RESULTS AND DISCUSSION

Three-year-old chinook comprised the largest (49.6%) age class, followed by age 4 (42.4%), age 2 (6.1%) and age 5 (1.9%) (Table 6). The percentage of age 2 chinook is the lowest observed during ten years of seining by the USFWS. The percentage of age 3 and 4 chinook was greater than their respective 1979 through 1988 age class means. The percentage of five-year-olds was close to the ten-year average.

The age data was divided into four equal time intervals to determine if there were any differences in run timing by age class. A Pearson 2-way chi-square analysis indicated significant differences ($p<0.05$) in run timing. Four-year-old chinook were the strongest year class initially and decreased in strength as the season progressed (Table 7). The early entry of the age 4 year class has been noted in previous seasons except in 1987. The age 3 year class comprised 39.0% of the initial interval, increasing to 62.6% of the final interval. Age 2 chinook comprised a low percentage (6.0%) in the early run timing, but increased to 13.7% in the last interval. The late-season increase of age 2- and 3- year-olds has occurred in former seasons and is attributed to the later entry of Trinity River stocks. These stocks have exhibited late run timing and are known to mature at an earlier age than IGH stocks.

TABLE 6. Percentage age composition, mean length, standard deviation and sample size of Klamath River fall chinook during the 1981-1988 return years.

Return Year		AGE AT RETURN 2	3	4	5
1981	**% Age Comp**	**32.9**	**53.6**	**12.0**	**1.5**
	$\overline{X}$	50.2	68.1	80.5	89.0
	s	4.95	6.85	6.09	5.95
	n	176	287	64	8
1982	**% Age Comp**	**29.1**	**32.0**	**36.1**	**2.3**
	$\overline{X}$	48.3	69.3	83.2	87.2
	s	4.25	6.51	7.02	7.48
	n	161	177	200	13
1983	**% Age Comp**	**12.9**	**54.3**	**31.4**	**1.4**
	$\overline{X}$	41.9	60.3	71.5	82.2
	s	3.73	4.82	6.07	6.77
	n	80	338	195	9
1984	**% Age Comp**	**13.0**	**40.0**	**45.0**	**2.0**
	$\overline{X}$	45.4	62.9	72.6	81.1
	s	3.89	3.96	4.78	7.89
	n	123	379	426	19
1985	**% Age Comp**	**25.7**	**38.0**	**29.6**	**6.5**
	$\overline{X}$	51.0	70.5	81.0	84.7
	s	4.99	4.23	5.60	5.32
	n	126	186	145	32
1986	**% Age Comp**	**22.9**	**64.4**	**11.8**	**0.9**
	$\overline{X}$	46.6	66.9	83.9	92.7
	s	5.37	5.71	6.87	5.06
	n	169	475	87	7
1987	**% Age Comp**	**10.5**	**38.4**	**48.2**	**2.5**
	$\overline{X}$	49.0	66.9	77.6	82.2
	s	5.38	5.75	5.85	5.63
	n	58	212	266	14
1988	**% Age Comp**	**6.1**	**49.6**	**42.4**	**1.9**
	$\overline{X}$	47.3	69.6	78.3	85.1
	s	4.93	5.17	6.27	7.69
	n	47	384	328	15

1/ $\overline{X}$ = mean fork length in cm, s = standard deviation of forklength and n = sample size

TABLE 7. Age class contribution of fall chinook salmon during four equal time intervals from the 1988 Klamath River beach seine sample determined through scale analysis.

	RUN TIMING				
Age	7/25 - 8/8	8/9 - 8/23	8/24 - 9/7	9/8 - 9/22	Total
2	6 (6.0%)	5 (2.4%)	17 (5.2%)	19 (13.7%)	47 (6.1%)
3	39 (39.0%)	90 (43.9%)	168 (51.7%)	87 (62.6%)	384 (49.6%)
4	52 (52.0%)	109 (53.2%)	135 (41.5%)	32 (23.0%)	328 (42.4%)
5	3 (3.0%)	6 (2.9%)	5 (1.5%)	1 (0.7%)	15 (1.9%)
Total	100 (100.0%)	205 (100.0%)	325 (100.0%)	139 (100.0%)	774 (100.0%)

The FWS age composition and CDFG run size estimates have been combined in this and previous reports to generate numbers of chinook in each age class group (Table 8). This information has allowed comparison of cohort groups through brood year cycles. These data are not available elsewhere, as the FWS beach seining provides the only age composition estimates of the entire fall chinook run. Consequently, these age composition and cohort data have been used to assist the estimation of ocean abundance of 3- and 4-year-old Klamath River fall chinook (PFMC 1988). These age and cohort estimates are presented for comparative purposes and are not intended to supplant those generated by the CDFG.

The 1987 and 1988 chinook runs have yielded low percentages of returning two-year-olds, 10.5% and 6.1% respectively (Table 6). Despite these low percentages, 101,250 age 3 returns (1985 brood year) in 1988 were second only to the 1986 return of three-year-olds (Table 8). The age 4 return (1984 brood year) was less than in 1987 but exceeded the ten-year average for age 4 returns. The 1984 brood year has produced an estimated 226,386 chinook returns to date, with the 5-year-old age class still outstanding for the 1989 return year. The return of 3,879 five-year-old chinook essentially completes the 1983 brood year cycle, the largest brood of the 1979 through 1988 return years (Figure 7). This 1983 brood year contributed an estimated 297,812 chinook returns to the Klamath River.

The two-year-old chinook age class has been monitored for assessing the strength of the brood. In certain past years, the relative abundance of returning jacks (age 2 chinook) has been a good indicator of its brood year strength. This association was observed for the 1977 to 1980 brood years and 1983 to 1985 brood year. During 1981 and 1982, despite the two consecutive years of the lowest jack returns, the total brood year contributions were equal or slightly less than the 1979 and 1980 brood year totals (Figure 7). The 1985 brood year has contributed an estimated 23,416 and 101,275 two- and three-year-olds, respectively. Although the age 4 and 5 cohorts are still outstanding, the 1985 brood year has already surpassed the returns from the 1979 through 1982 brood years. The return of 12,396 two-year-olds in 1988 is the lowest since the return of 6,993 jacks in 1984 (1982 brood year) and may be a potential concern for the 1986 brood year.

Two-year-olds did not differ ($p>0.05$) in length from the previous two seasons, but were significantly smaller ($p<0.05$) than two-year-olds returning in 1985 and significantly larger ($p<0.05$) than those in 1984 (Table 6). Three-year-olds were significantly larger ($p<0.05$) than those returning in 1984, 1986, and 1987, but were smaller than those returning in 1985. Four-year-old chinook did not significantly differ ($p>0.05$) in mean length from age 4 chinook returning in 1987, but were significantly larger than those returning in 1985 through 1986, and were significantly smaller ($p<0.05$) than 1984. Five-year-olds did not significantly differ ($p>0.05$) in size from those returning in 1984, 1985 and 1987, but were significantly smaller ($p<0.05$) than the 1986 return year.

TABLE 8. Estimated number of fall chinook by age entering the Klamath River during the 1979-1988 return years.

Return Year	AGE 2	3	4	5	Total
1979	8,867	20,197	28,695	3,818	61,577
1980	47,021	14,430	15,484	4,135	81,070
1981	34,567	56,315	12,608	1,576	105,066
1982	30,316	33,338	37,609	2,917	104,180
1983	7,817	32,905	19,028	849	60,599 1/
1984	6,993	21,517	24,206	1,076	53,792 1/
1985	34,023	50,306	39,186	8,870	132,385 1/
1986	54,200	152,421	27,928	2,130	236,679 1/
1987	23,416	85,634	107,489	6,467	223,006 1/
1988	12,452	101,250	86,552	3,879	204,133
1979-1988 Average	25,967	56,831	39,878	3,572	126,248

1/ Estimated total and associated numbers for 1983 and 1987 differ slightly from those published in previous annual reports due to changes in CDFG run size estimates.

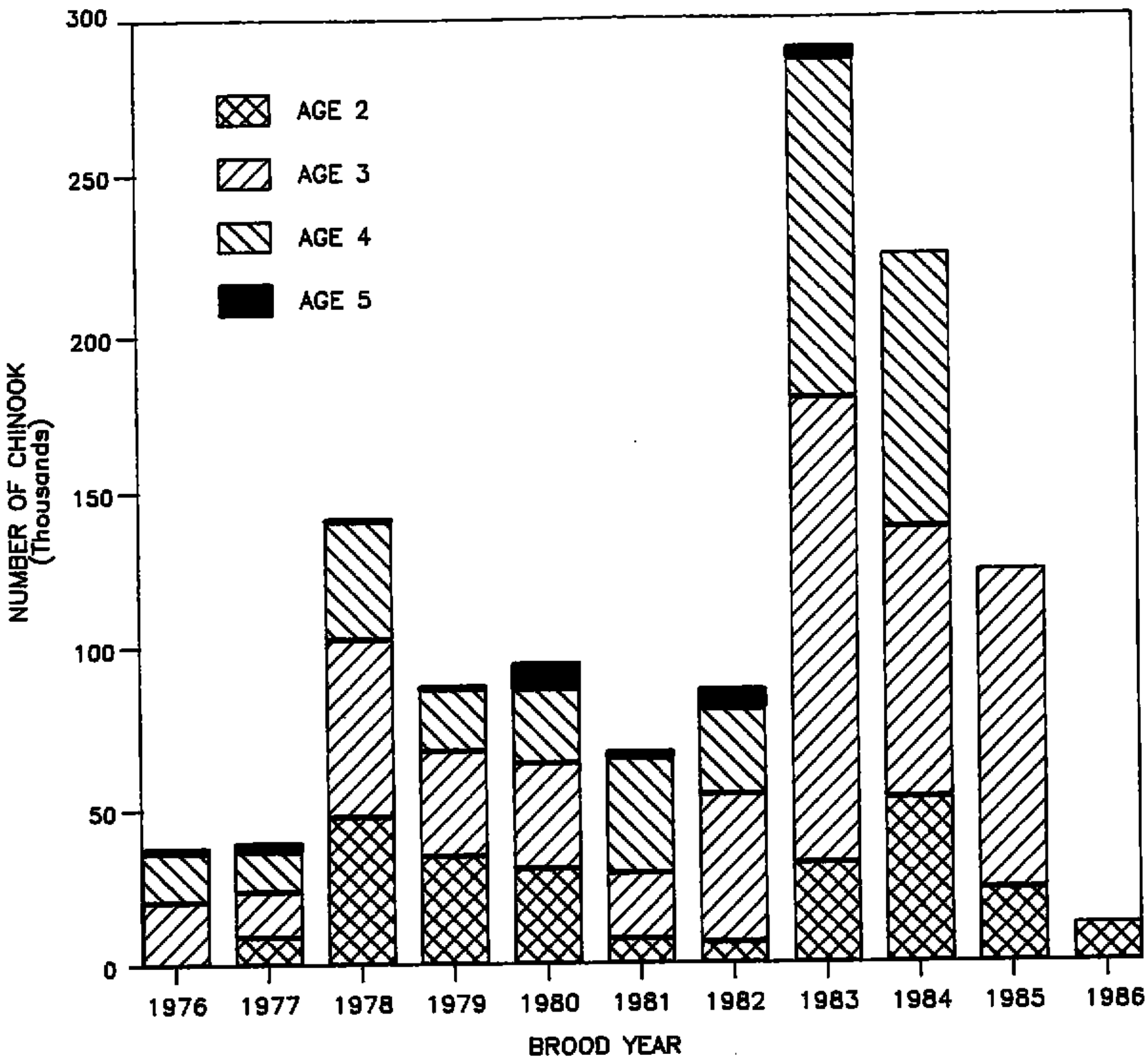

Figure 7. Brood year contributions by age of fall chinook salmon to the 1979-1988 Klamath River returns.

NET HARVEST MONITORING PROGRAM

INTRODUCTION

Hoopa, Karok and Yurok Indian people living along the Klamath and Trinity Rivers have traditionally fished for salmon, steelhead, sturgeon and other species using a variety of fishing gear including weirs, dip nets, spears and gill nets. Historically, salmon consumption by these people exceeded 907,000 kg (2 million pounds) annually (Hoptowit 1980). For historical accounts of the Indian fisheries see Hoptowit (1980), Bearss (1981) and FWS (1981).

Regulations governing recent Indian fishing on the HVR were first published by the DOI in 1977 and FAO-Arcata biologists began monitoring net harvest levels on the Reservation in 1978 (FWS 1981), with efforts focused on fall chinook salmon. Further progress was made in ascertaining net harvest levels with the establishment of a net harvest monitoring station in the lower Klamath River in 1980. Net harvest monitoring operations were expanded up river beginning in 1981 for Reservation-wide coverage of the net fishery. Since 1983, FAO-Arcata biologists have focused monitoring efforts solely on the Klamath River portion of the Reservation, operating three monitoring stations based near Requa, Omagar Creek and Johnson. Responsibility for monitoring net harvest levels on the Trinity River portion of the HVR was taken over by the HVBC Fisheries Department in 1983.

Beginning in 1984, FAO-Arcata biologists employed a stratified random sampling methodology to assess fall season net harvest levels for chinook salmon, coho salmon, steelhead trout and sturgeon on the Klamath River portion of the HVR in an attempt to improve the accuracy and gauge the precision of the harvest estimates. The techniques employed during former seasons yielded point estimates without associated measures of variance. Although they are considered reasonably reliable and accurate, no quantifiable measure of precision can be calculated for estimates made prior to 1984.

Allocation between the various user groups of the Klamath River fall chinook resource (ocean commercial, ocean sport, river sport and Indian gill net) was agreed upon in 1986. This allocation allowed harvest of the chinook resource and yet provided for the rebuilding of the chinook population. Toward this goal, the DOI enacted regulations designed to meet the harvest quota established by the allocation agreement for the Indian gill net fishery.

METHODS

Net harvest monitoring data were collected and compiled from three contiguous areas (Estuary, Middle Klamath and Upper Klamath) of the Klamath River portion of the HVR in 1988 (Figure 8). The Estuary Area was defined as the lower 6 km of the river from the mouth to the crossing of the U.S. Highway 101 bridge. The Middle Klamath comprised the next 27 km of river from the crossing of the Highway 101 bridge to Surpur Creek, 33 km upstream from the mouth. The Upper Klamath Area included the next 37 km stretch of river from Surpur Creek to Weitchpec. During the 1988 fall chinook fishery, DOI regulations divided

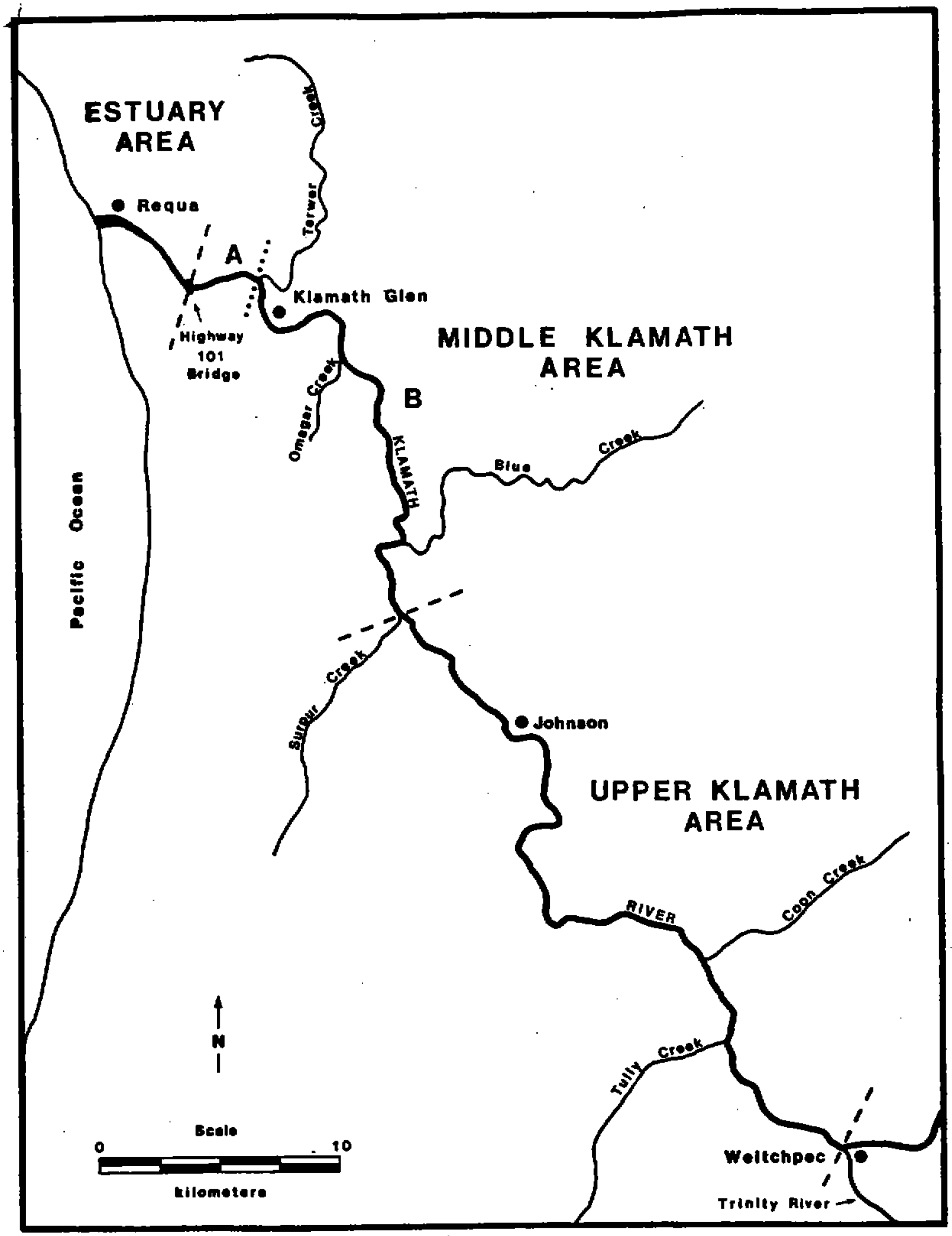

Figure 8. Net harvest monitoring areas for the Klamath River portion of the Hoopa Valley Reservation in 1988.

the reservation into three management zones that differ from the above areas. These zones, coupled with time closures were designed to allow equitable distribution of harvest throughout the HVR and yet to allow fishing through the fall chinook season. Area I included the portion of Klamath River from the mouth to the U.S. Highway 101 bridge (River km 6). Area II began at the crossing of the U.S. Highway 101 bridge and continued upriver to the confluence of the Trinity River (River km 70). Area III consisted of the Trinity River portion of the HVR. FAO-Arcata biologists monitored the harvest in Management Areas I and II while the HVBC Fisheries Department was responsible for estimating the harvest in Management Area III. In order to keep the data as comparable to previous years as possible, data in this report will be analyzed with regard to the three monitoring areas utilized in previous years.

Fall Fishery

The design employed by FAO-Arcata biologists to estimate harvest in 1988 involved a stratified random sampling technique with an optimum allocation of sampling effort based on the available data and associated variances. The actual estimate is comprised of two parts: an estimate or count of total effort and an estimate of average catch per net for each area and net type. Each part of the estimate has an associated variance estimate. These variances are combined to give an estimated daily variance. The daily estimates of catch and variance are expanded to total estimates of catch and variance by area, net type and time period, usually semi-monthly. Following are the methodologies utilized for monitoring fall chinook harvest in each area and for subsequent data analyses.

Estuary Area

Under pre-season DOI regulations, the Estuary (DOI Management Area I) was open to gill net fishing from Monday at 1700 to the following Monday at 0900, until July 31, after which the Estuary was open to gill net fishing from 1900 to 0700 Monday through Saturday. The Estuary Area was closed August 25 after the attainment of its harvest quota. The Estuary Area was monitored every day it was open from July 13 to August 25 by a field crew composed of one biologist and one Indian technician.

The Estuary Area was divided into two sections to estimate fishing effort. Section 1 included the area from the mouth to Panther Creek and Section 2 included the area from Panther Creek to the Highway 101 Bridge. Section 1 was a high effort area where nets were fished for varied lengths of time. Total net counts were conducted every 2 hours when the Estuary was open to fishing. Section 2 has typically been a low effort area and net counts were conducted once in the evening. During the commercial fishery (August 1 through 20) an increase in effort in Section 2 lead to a changing in methodology where total net counts in Section 2 were conducted every 4 hours. Indian fishers were interviewed to obtain information on the number of each fish species caught, the number of nets fished and the number of hours that were fished. From this information, harvest and variance estimates were generated. During the commercial fishery, a total harvest estimate was calculated on a weekly basis and the number of chinook sold during that week was subtracted from the total harvest estimate to derive the subsistence harvest estimate.

When possible, harvested fish were measured to the nearest centimeter forklength, examined for tags and fin-clips, and inspected for seal or otter-bite damage. Snouts were removed from adipose fin clipped salmonids for subsequent CWT recovery and identification. A subsample of fall chinook harvested in the Estuary Area were weighed to the nearest pound and these weights were converted to kilograms.

The commercial fishery buying station located at Requa was monitored from August 1 to August 18. To optimize the nightly sampling effort, the buying station was monitored during the first 6 hours the fishery was open since the majority of the landings occurred during this time. All sampled chinook were examined for ad-clips and the snouts were removed from ad-clipped salmon. Approximately 20% of the examined chinook salmon were randomly sampled for fork length, finclip and age (scale) data.

Middle Klamath Area

One field crew consisting of one biologist and one Indian technician, working from a camp near Omagar Creek, monitored the Middle Klamath Area. Under pre-season DOI regulations the Middle Klamath Area is part of Management Area II and was open for fishing under pre-season DOI regulations six days per week, beginning Tuesday at 1700 and continuing until the following Monday at 0900 from August 1 to September 30. The fishery was monitored 4 to 5 days per week from August 3 to October 22. To monitor the set net fishery, a total net count was conducted by boat after dark over the entire section of river. At dawn, the crew contacted Indian fishers and sampled the set net harvest.

To monitor the drift net fishery, total net counts were conducted by boat between 2000 hours and 0100 hours when drift netting typically occurs. The harvest was sampled either that evening or the following morning. Interviews with drift and set net fishers were conducted in a like manner to those in the Estuary Area.

Upper Klamath Area

One field crew, consisting of one biologist and one Indian technician working out of a camp at Johnson, monitored the Upper Klamath Area. Under DOI regulations, the Upper Klamath Area was included in Management Area II and as such was open during the same period as the Middle Klamath Area. The crew monitored the fishery 4 to 5 days per week from August 1 to October 29. The sampling methodologies for set and drift net fisheries were the same as in the Middle Klamath Area.

Harvest Estimate and Associated Variance Calculations

Definitions and notations for all equations presented herein are summarized as follows:

a = Number of fishing days available in the time period.

$\bar{c}$ = Daily mean catch per net or net hour.

$\hat{C}_i$ = Estimated catch for the ith day.

$\hat{C}_p$ = Estimated catch for the pth period.

s = Number of days sampled in the time period.

t = t value at the 95% level.

Y = Daily total number of nets fished.

y = Daily number of nets sampled.

$\hat{Y}$ = Estimated daily total number of net hours fished.

$\hat{V}(\hat{C}_i)$ = Estimated variance of daily catch.

$V(\overline{C}_i)$ = Variance of the mean catch per net or net hour.

$\hat{V}(\hat{C}_p)$ = Estimated variance of catch for the pth period.

$V(C_s)$ = Daily variance of catch.

$\hat{V}(\hat{Y})$ = Estimated variance of daily total number of net hours fished.

Estuary (section 1) estimates ($\hat{C}_i$) of catch by species were calculated by multiplying mean catch per net hour values by the total number of net hours fished:

$$(1a)\quad \hat{C}_i = (\hat{Y}_i)(\overline{C}_i)$$

Estuary (section 2), Middle Klamath and Upper Klamath Areas estimates ($\hat{C}_i$) of catch by species were calculated by multiplying mean catch per net values by the respective total net count:

$$(1b)\quad \hat{C}_i = (Y)(\overline{C}_i)$$

Since the harvest was not sampled every day fishing occurred, the harvest was estimated for time periods using the equation:

$$(2)\quad \hat{C}_p = (\hat{C}_i)\ \frac{a}{s}$$

These estimates of catch were summed to yield the season harvest estimate.

Estimated harvest of the subsistance fishery in the Estuary Area (Section 1 and 2) was calculated by subtracting the commercial harvest from the total daily harvest estimate.

The variance associated with the Estuary strata harvest estimate was calculated by using the equation (Goodman 1960):

$$(3a)\quad \hat{V}(\hat{C}_i) = (\overline{C}_i)^2\,[\hat{V}(\hat{Y}_i)] + (\hat{Y}_i)^2\,[V(\overline{C}_i)] - [\hat{V}(\hat{Y}_i)]\,[V(\overline{C}_i)]$$

The variance associated with daily harvest estimates in the Middle Klamath and Upper Klamath Areas was calculated by using the equation:

$$(3b)\quad \hat{V}(\hat{C}_i) = V(\hat{C})(Y\ /\ y)$$

Because the catch variance is estimated on a daily basis, it must be expanded to include days fished but not sampled. The variance associated with the catch estimate for a time period is calculated by the equation (Cochran 1977):

$$(4)\quad \hat{V}(\hat{C}_p) = \frac{a(a-s)\quad (\hat{C}_i - \bar{C})^2}{s(a-1)} + \frac{a\ [\ \hat{V}(\hat{C}_s)]}{s}$$

Once the estimate and associated variance were calculated for a period, the corresponding 95% confidence interval was calculated by:

$$(5)\quad 95\%\ \text{Confidence Interval} = \pm\ (t_{.975})\text{SQRT}\frac{\hat{V}(\hat{C}_p)}{a}$$

Spring Fishery

FAO-Arcata personnel monitored the fishery from the mouth to Surpur Creek (Estuary and Middle Klamath Areas) and from Johnsons to Weitchpec (Upper Klamath Area), on a periodic basis from April 4 to July 29.

During the spring monitoring period, Indian fishers were contacted while in their boats, at their riverside camps, or at boat landings in the area. Information obtained included number of fish caught, species identification, mesh size, and number of nets fished. River surveys, including net counts, were scheduled to coincide with hours when fishers typically checked their nets. Indian fishers not contacted on the river were later interviewed at their residences. Chinook were bio-sampled in the spring net fishery in the same manner previously described for the fall fishery.

Procedures used in estimating net harvest for the three Klamath monitoring areas during the 1988 spring fishing period were similar to those of previous years. Estimated daily and monthly net harvest levels were derived by: (1) summing numbers of chinook measured, seen but not measured and reported caught by reliable sources, and (2) dividing these respective sums by the estimated percentage of net harvest these sums were judged to represent. These judgements were based on net counts, a network of contacts on the reservation and on intimate knowledge of the net fisheries. Spring chinook harvest estimates were determined monthly for each of the three areas.

Statistical analysis of data was limited to the t-test unless otherwise noted. The data were compared at the 95% confidence level.

RESULTS AND DISCUSSION

Fall Chinook

An estimated 46,892 fall chinook salmon were harvested by the gill net fishery on the Klamath River portion of the HVR in 1988 (Table 9). The majority of the harvest (79.0%) occured in the Estuary Area, followed by the Middle Klamath Area (13.4%) and Upper Klamath Area (7.6%). Gill net harvest estimates corresponding to Department of Interior management areas were 36,914 adult fall chinook harvested in Management Area I (Estuary Area) and 9,667 adult fall chinook harvested in Management Area II (Middle and Upper Klamath Areas).

A total of 138 jack (<56 cm) and 36,914 adult fall chinook salmon were harvested in the Estuary Area (Table 10). The adult harvest was partitioned into 25,782 (69.8%) salmon for the commercial fishery and 11,132 (30.2%) salmon for the subsistence fishery. Daily harvests in the Estuary Area ranged from 19 chinook salmon on July 25 to 3,643 on August 17. Peak weekly harvest of 12,580 chinook salmon occured during August 15 to 20. During the 1988 commercial fishery, the highest level of fishing effort in the Estuary Area was observed since the Service began net harvest monitoring. In 1988, the peak net count was 326, while in 1987 the peak net count was 259. The average peak net count from 1981 to 1986 was 53 with a range of 30 to 85 nets.

TABLE 10. The number and percentage of jack and adult fall chinook salmon harvested by the gill net fishery on the Klamath River portion of the Hoopa Valley Reservation in 1988.

Area	Jack	(%)	Adult	(%)	Total	(%)
Estuary[1/]	138	(0.4%)	36,914	(99.6%)	37,052	(79.0%)
Middle Klamath	36	(0.6%)	6,252	(99.4%)	6,288	(13.4%)
Upper Klamath	137	(3.9%)	3,415	(96.1%)	3,552	(7.6%)
Total All Areas	311	(0.7%)	46,581	(99.3%)	46,892	(100.0%)

1/ Estuary harvest includes both subsistence and commercial harvest.

Fall chinook salmon harvest for the Middle Klamath Area was 36 jacks and 6,252 adults (Table 10). Daily harvest levels ranged from 0, occuring frequently during the first two weeks in August, to 630 on September 16 with a

TABLE 9. Semi-monthly estimates of fall chinook salmon harvest by the gill net fishery on the Klamath River portion of the Hoopa Valley Reservation in 1988.

Time Period	NET HARVEST MONITORING AREA Estuary 1/	Middle Klamath	Upper Klamath	Semi-Monthly Totals (All Areas)	Cumulative Seasonal Total
July 1 - 15	**384** 2/ 159 3/ 41.4% 4/ 68 5/	**0** - - -	**0** - - -	**384**	**384**
July 16 - 31	**1,276** 70 5.5% 679	**0** - - -	**0** - - -	**1,276**	**1,660**
August 1 - 15	**21,040** 661 3.1% 10,626	**21** 6 28.6% 7	**103** 45 43.7% 42	**21,164**	**22,824**
August 16 - 31	**14,352** 643 4.5% 8,404	**924** 50 5.4% 395	**762** 63 8.6% 458	**16,038**	**38,862**
September 1 - 15	**0** - - -	**3,274** 189 5.8% 1,571	**1,085** 82 7.6% 559	**4,359**	**43,221**
September 16 - 30	**0** - - -	**1,641** 33 2.0% 753	**1,193** 25 2.1% 757	**2,834**	**46,055**
October 1 - 15	**0** - - -	**386** 53 13.7% 103	**308** 17 5.5% 147	**694**	**46,749**
October 16 - 31	**0** - - -	**42** 14 33.3% 17	**101** 7 6.9% 62	**143**	
Area Season Total	**37,052** 1,533 4.1% 19,777	**6,288** 345 5.5% 2,846	**3,552** 239 6.7% 2,025		**46,892** 2,117 4.5% 24,648

1/ Includes commercial and subsistence fishery.
2/ Harvest estimate.
3/ 95% Confidence interval.
4/ Confidence interval percentage.
5/ Accounted number of fall chinook.

peak weekly harvest of 2,178 occuring between September 11 and 17. Fishing effort in the Middle Klamath Area was greatly reduced, ranging from 0 to 4 nets fished per night, during the time the Estuary Area was open to commercial fishing but increased to "traditional" levels after the commercial fishery was closed.

One-hundred and thirty-seven jacks and 3,415 adult fall chinook were harvested in the Upper Klamath Area (Table 10). Daily harvest levels in the Upper Klamath Area ranged from 0 on August 4 to 256 on September 16. Peak weekly harvest occured during September 11 to 17. A decrease in fishing effort in the Upper Klamath Area did not occur as it did in the Middle Klamath Area during the Estuary commercial fishery. Effort levels were similar to those observed in past years.

Mean length of chinook jacks (44.4 cm) was significantly smaller than jacks harvested in 1985-1987 (Figure 9). Mean length of harvested adults (78.1 cm) was not significantly different ($p>0.05$) from that of adults harvested in 1987, but was significantly greater ($p<0.05$) than the mean lengths of adults harvested in 1985 and 1986.

Mean length of adults harvested in the Estuary Area were significantly greater ($p<0.05$) than adults harvested in the Middle and Upper Klamath Areas (Figure 10). Mean length of adults harvested in the Middle Klamath Area was significantly greater ($p<0.05$) than that of adults harvested in the Upper Klamath Area.

Mean length of adults harvested in the Estuary Area in 1988 did not differ significantly ($p>0.05$) from mean lengths of adults harvested in 1985-1987 (Figure 11). The stability of mean length of the harvest in the estuary show the selectivity of the gear towards the specific portion of the population.

Lengths and weights from 177 fall chinook were used to calculate a length-weight regression (Figure 12). Mean length and weight of chinook was 78.7 cm and 7.3 kg, respectively. The formula describing the length-weight relationship is: [Log(weight)= -5.091 + 3.137 Log(fork length) $R^2 = 0.90$. Comparing weights using annual length-weight regressions, a 75 cm chinook returning in 1988 would have weighed 6.1 kg. A 75 cm chinook would have weighed 5.8 kg in 1987, 5.5 kg in 1986, 6.3 kg in 1985 and 6.9 kg in 1984.

Adipose fin-clips were observed on 8.1% of the fall chinook mark sampled in all monitoring areas combined and on 8.2%, 7.1% and 8.5% of the fall chinook mark sampled in the Estuary, Middle Klamath and Upper Klamath Areas, respectively. Mean length of ad-clipped chinook harvested in all monitoring areas combined was 76.2 cm ($s=6.14$, $n=247$) for adults and 48.2 cm ($s=2.05$, $n=5$) for jacks.

A total of 15,923 (61.8%) of the 25,782 commercially sold fall chinook salmon were sampled for adipose fin-clips and 815 chinook were sampled for length and age data. Ad-clips were observed on 973 (6.1%) of the sampled chinook. Mean length of ad-clipped chinook was 77.5 cm ($s = 5.78$). Mean length of randomly sampled chinook salmon was 77.8 cm ($s=5.95$).

Age composition of commercially caught chinook salmon shows the selectivity of the gill net fishery towards larger and older fish (Table 11). Data collected at the commercial buying station slightly under estimated the

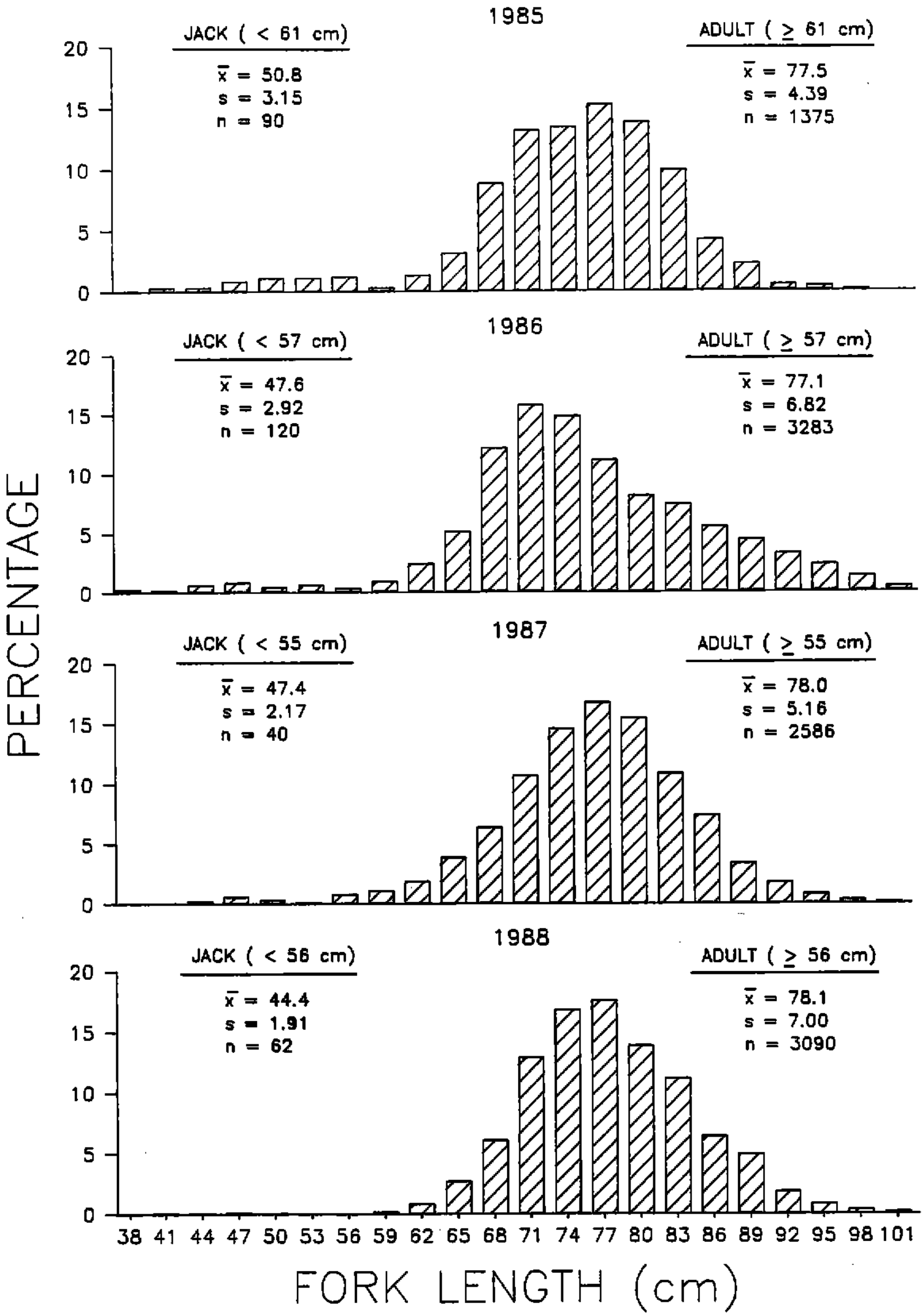

Figure 9. Length frequency distributions of fall chinook salmon harvested by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1985-1988.

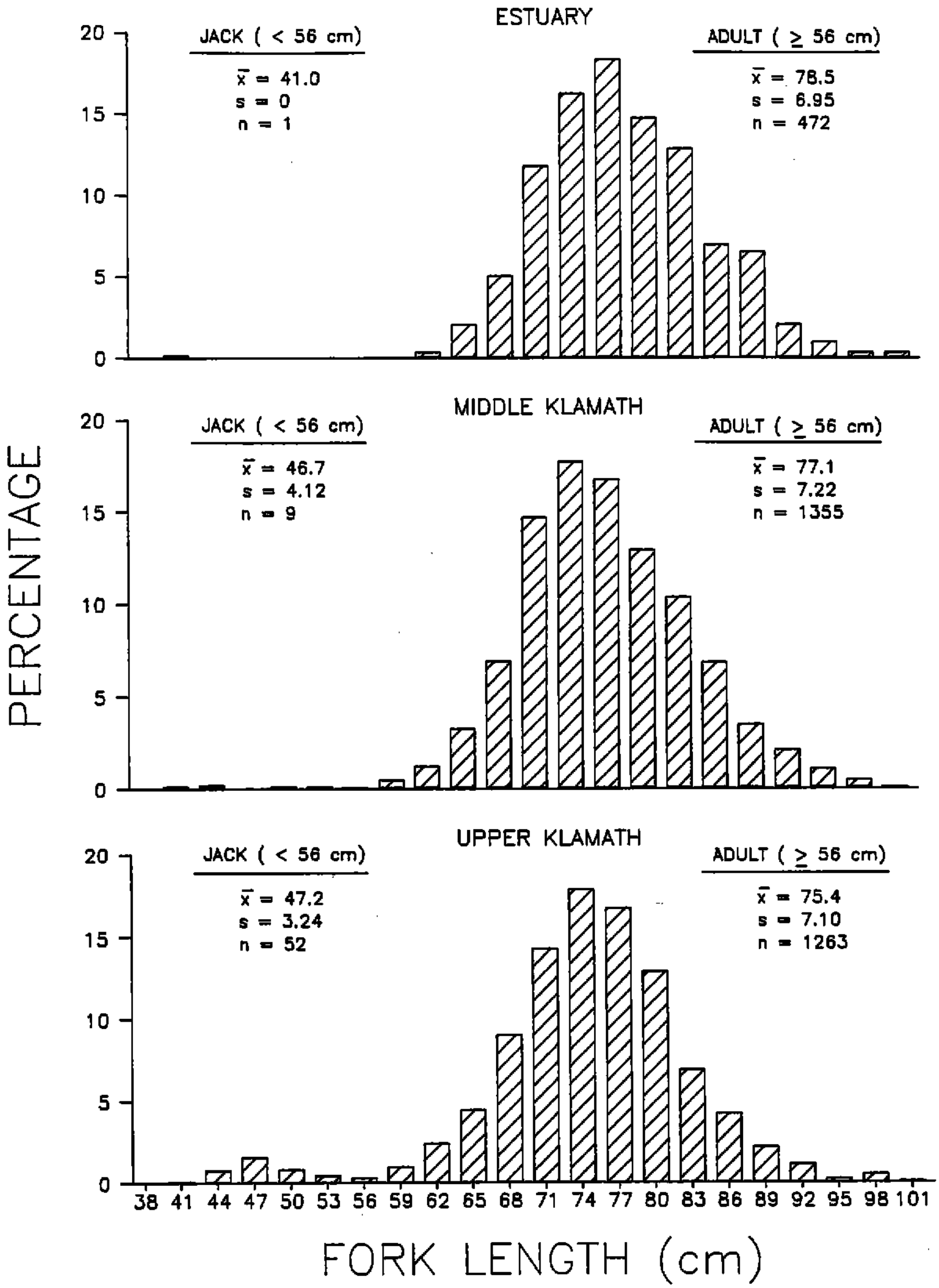

Figure 10. Length frequency distributions of fall chinook salmon harvested by Indian gill net fishers in the Estuary, Middle Klamath and Upper Klamath Areas in 1988.

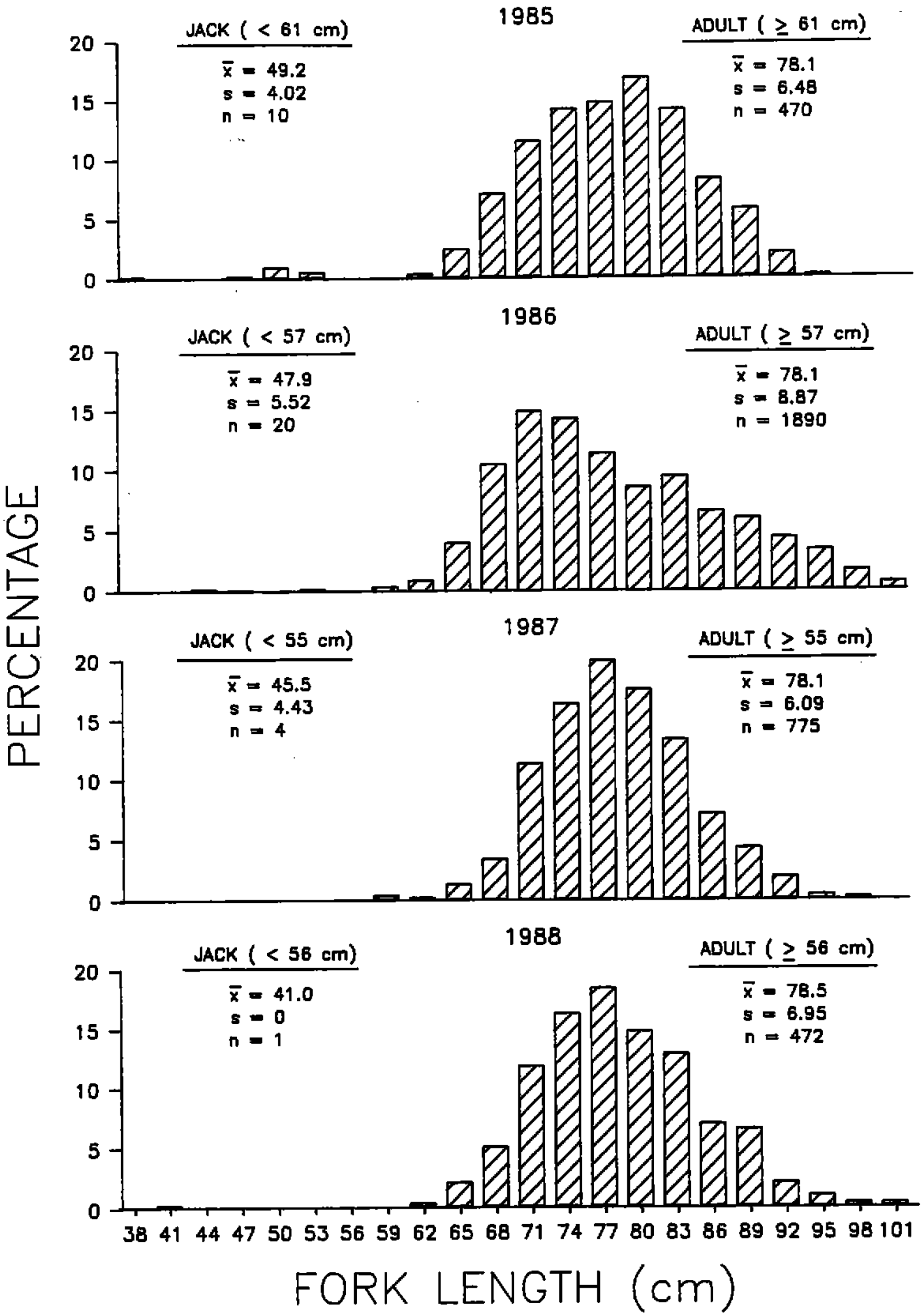

Figure 11. Length frequency distributions of fall chinook salmon harvested by Indian gill net fishers in the Estuary Area during 1985-1988.

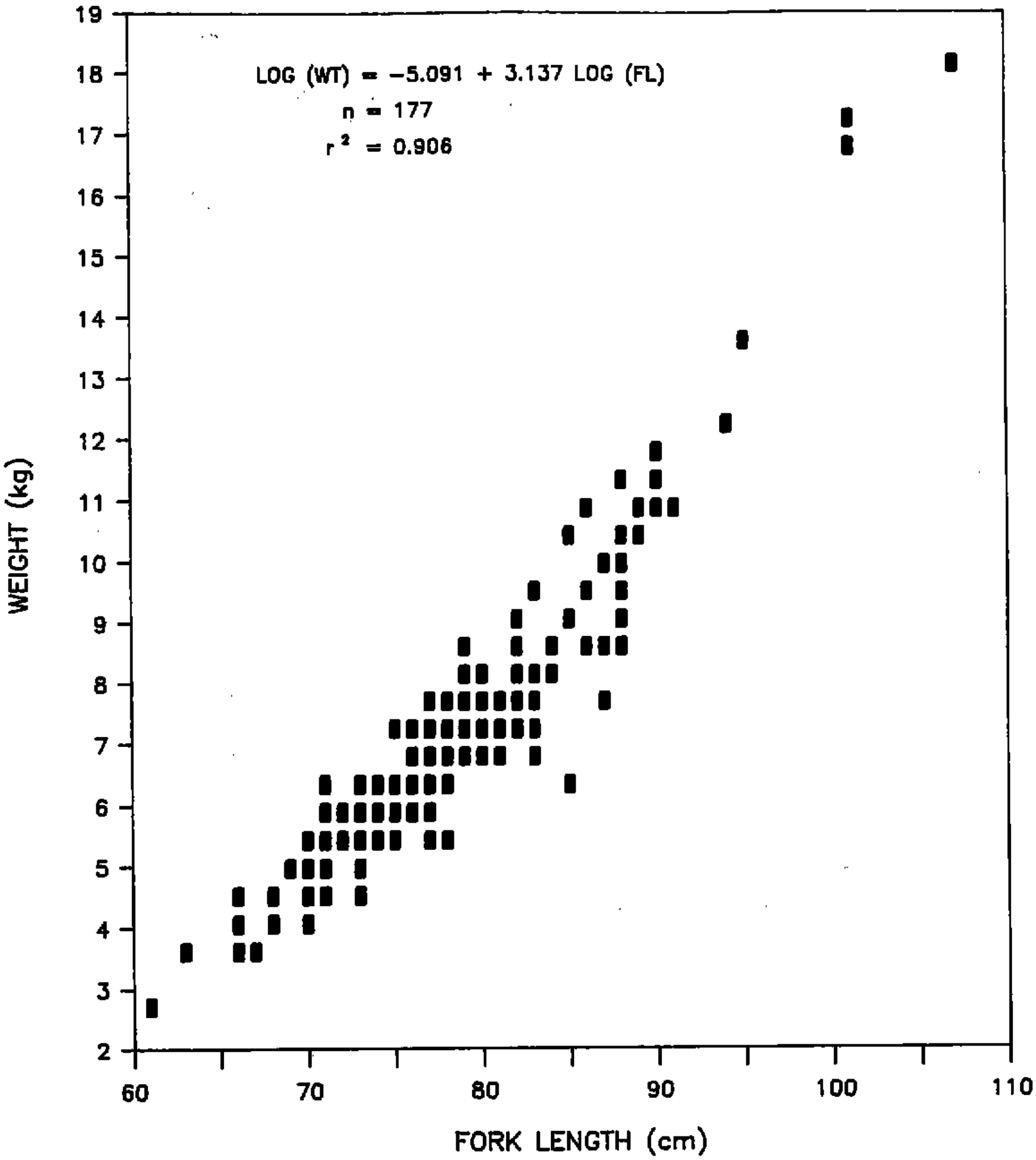

Figure 12. Length-weight relationship of fall chinook salmon harvested by Indian gill net fishers in the Estuary area in 1988.

percentage of age 3 chinook harvested due to the 66 cm total length (61 cm fork length) minimum size limit imposed on commercially landed chinook salmon. This bias is thought to be small since only a small percentage of 3-year-old chinook (4.2%) sampled in the beach seining operation were less than 61 cm fork length. Age composition of weekly harvest did not vary substantially during the commercial season but it did differ from weekly age composition data collected from the beach seining operation.

TABLE 11. Fall chinook age composition of the weekly commercial harvest, the season commercial harvest and the August 1 to 20 beach seine catch.

	AGE 2	AGE 3	AGE 4	AGE 5
Commercial Harvest				
Week of:				
Aug 1-6	0.0%	18.9%	78.9%	2.2%
Aug 8-13	0.0%	14.3%	82.9%	2.9%
Aug 15-20	0.0%	17.1%	81.0%	1.9%
Commercial Harvest (Season)	0.0%	16.4%	81.2%	2.4%
Beach Seine (Aug 1 to 20)	4.0%	34.1%	65.1%	0.8%

Bite marks from seals (Phoca vitulina) or sea lions (Zalophus californicus and Eumetopias jubatus) were observed on 1.3% of the chinook salmon sampled in the Estuary Area in 1988. This is the lowest value for "seal" bites in the seven years that comparable data has been collected. The 1987 Annual Report (USFWS 1988) suggested that the low frequency of "seal" bites may have been due to the regulation of constant net monitoring by the fishers which would decrease the opprotunities for "seal" depredation. In 1988 this regulation was also in effect but since the commercial buyer was more selective in the purchase of fish many fishers may have kept damaged fish for themselves, which would have reduced their probability of being sampled. Seal bites were observed on 0.6% and 2.3% of the fall chinook sampled in the Middle Klamath and Upper Klamath Areas, respectively. Percentages of seal bitten fish represent minimum values of depredation because they do not account for fish removed from nets by predators severely damaged fish that were discarded and not reported as being caught.

Bites attributed to the river otter (Lutra canadensis) were observed on 0.7% of the fall chinook in the Middle Klamath Area and on 3.5% in the Upper Klamath Area.

Spring Chinook

An estimated 2,926 spring chinook, 2,918 adults (>53) and 8 jacks were harvested by the gill net fishery on the Klamath River portion of the HVR in 1988 (Table 12). The majority of the spring chinook harvest (57.3%) occured in the Estuary Area, followed by the Middle Klamath Area (24.3%) and the Upper Klamath Area (18.4%). Most of the harvest in the Middle and Upper Klamath Areas occured in June and July. The high level of spring chinook harvest in the Estuary Area in July 1985, 1987 and 1988 can be attributed to the timing of the spring/fall run. (See Coded Wire Tag Investigations Section).

TABLE 12. Estimates of spring chinook salmon harvest in the gill net fishery on the Klamath River portion of the Hoopa Valley Reservation in 1988.

	NET HARVEST MONITORING AREA				
Time Period	Estuary	Middle Klamath	Upper Klamath	Monthly Totals	Cumulative Total
April	2	20	18	40	40
May	251	178	294	723	763
June	225	512	227	964	1,727
July	1,199	0	0	1,199	2,926
TOTAL	1,677	710	539	2,926	

Mean length of adult spring chinook (68.9 cm) harvested in 1988 was significantly smaller ($p<0.05$) than spring chinook harvested in 1985-1987 (Figure 13). No spring chinook jacks were measured in 1988.

Adipose fin-clips were observed on 14.6% of the sampled spring chinook harvested during April through June. Mean length of ad-clipped spring chinook was 69.6 cm ($s= 4.78$, $n= 15$).

Spring and fall chinook harvest estimates for 1977 to 1988 are summarized in Table 13.

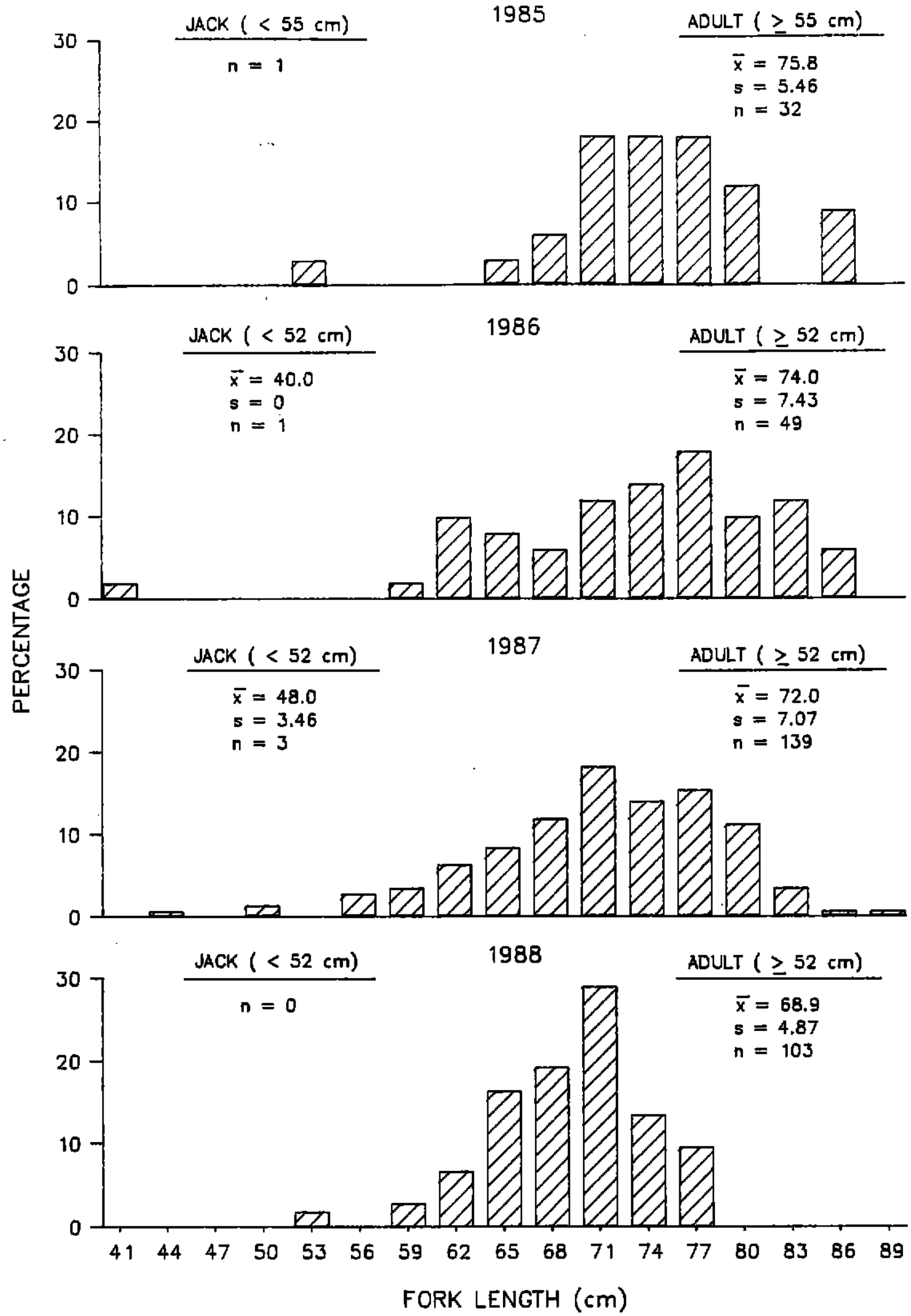

Figure 13. Length frequency distributions of spring chinook salmon harvested by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1985-1988.

TABLE 13. Estimates of spring and fall chinook salmon harvest by the gill net fishery on the Hoopa Valley Reservation during 1977-1988[1/].

	SPRING CHINOOK			FALL CHINOOK		
Year	Jacks	Adults	Total	Jacks	Adults	Total
1977	--	--	--	2,700	27,300	30,000
1978	--	--	--	1,800	18,200	20,000
1979	--	--	--	1,350	13,650	15,000
1980	20	980	1,000	987	12,013	13,000
1981	57	2,807	2,864	2,465	33,033	35,498
1982	45	3,155	3,200	1,799	14,482	16,281
1983	10	585	595	163	7,890	8,053
1984	12	627	639	455	18,670	19,125
1985	160	2,074	2,234	1,555	11,566	13,121
1986	95	2,714	2,809	854	25,127	25,981
1987	176	5,792	5,968	415	53,096	53,511
1988	92	5,645	5,737	578	51,651	52,229

1/ Estimates for 1983-1988 Trinity River net fishery were obtained from the Hoopa Valley Business Council, Fisheries Department. All other harvest estimated by the Fish and Wildlife Service by methods described in previous annual reports.

RECOMMENDATIONS

The management of the lower Klamath River Indian gill net fishery has been relatively low-key and of minimal biological concern before 1987. As long as the ocean fisheries were the primary harvester of the fall chinook resource and the gill net fishery was relegated to subsistence and ceremonial harvest of chinook, concern over fishery impacts centered on the ocean harvest. With the agreement between ocean and in-river user groups in 1987 to share the allowable harvest, and to shift a substantial part of that allowable harvest in river, an increased importance as to how the Indian gill net fishery is managed should be recognized.

With the increased allowable in-river harvest has come the creation of a Indian commercial gill net fishery in the estuary. Fishing effort has been substantially higher during the commercial fishery in 1987 and 1988 than comparable periods before the formation of the commercial fishery. The impacts on the fall chinook salmon resource have been the following: (1) An imbalance in the harvest towards Iron Gate stocks. During the 1988 commercial fishery (August 1 through 20) 67.7% of the estimated harvest of adipose-fin clipped chinook originating from basin hatcheries were from Iron Gate Hatchery. Fall chinook from Trinity River Hatchery (TRH) accounted for 26.0% of the harvest of adipose-fin clipped chinook and spring chinook from TRH accounted for the remaining 6.3%. This imbalance of impacts on the hatchery stocks can be attributed to the timing of the commercial fishery and the run timing of the two fall chinook stocks. At the time of the commercial fishery, Iron Gate stocks predominated in the estuary while TRH stocks did not contribute heavily to the harvest until the third week of August. (2) An imbalance towards harvest of older (4- and 5-year-old) chinook. The age composition of the commercial harvest in 1988 was 0.0% age 2, 16.4% age 3, 81.5% age 4, and 2.4% age 5. Age composition of beach seine captured chinook for the period of the commercial fishery was 3.8% age 2, 32.8% age 3, 62.6% age 4 and 0.8% age 5.

We believe the shortening of the estuary fishery from July 15 through September 15 to July 15 through the middle of August was the primary cause of these impacts. Net selectivity has also contributed to the imbalance although the effect of net selectivity was recognized prior to the allocation agreements and was factored into the allocation model. In accordance with the role of technical advisor to the Bureau of Indian Affairs and as stewards of the fisheries resources in the Klamath basin, the Fish and Wildlife Service makes the following recommendations concerning management of the Indian gill net fishery:

- **Spread the harvest into September to take advantage of Trinity hatchery** stocks. This could be accomplished by delaying the start of the commercial fishery until after August 15 or by splitting the season into an August segment (August 4 to 18) and a September segment (September 1 until attainment of harvest quota), with a two week closure separating the fishing segments. This would afford additional protection for Klamath natural stocks which is desirable realizing the current restoration efforts and would balance the impacts between Iron Gate and TRH stocks.

- **Eliminate the 66 cm total length size limit on commercially sold fish.** This has no biolgical significance and could increase the total number of fish sold and prevent small fish from being tossed back. Because of California State Laws that inhibit the commercial buyers from processing fish less than 66 cm total length, a tribal enterprise could be set up to utilize small fish.

- **Nets fished in the Estuary should be attended at all times.** By constantly tending the nets, the loss of salmon to seal and sealion depradation could be reduced.

- **Openings of management areas should be concurrent to prevent effort** shift.

CODED-WIRE TAG RECOVERY INVESTIGATIONS

INTRODUCTION

Two hatcheries operated by the CDFG are located in the Klamath River Basin. Trinity River Hatchery, at the base of Lewiston Dam, lies 249 river kilometers from the mouth of the Klamath River. Located near the base of Iron Gate Dam on the Klamath River, IGH lies 306 river kilometers from the mouth (Figure 1). Three release strategies are represented by groups of CWT juvenile chinook salmon at the two hatcheries: fingerlings in June, yearlings in October and yearling-plus in March. In addition, several fingerling and yearling groups are released at off-site (away from the hatchery) locations. In 1983, CDFG began to implant natural spawned fingerling chinook with CWT's as part of their natural stock assessment program.

Different release strategies introduce variation that must be analyzed in order to evaluate their individual effectiveness. Information must also be gathered to assess fishery related impacts acting on existing fish stocks. With this realization, FAO-Arcata biologists conducted CWT recovery efforts in conjunction with 1988 net harvest monitoring activities on the Klamath River portion of the HVR.

METHODS

Methods of acquiring CWT samples during net harvest monitoring activities were previously described in this report. Coded-wire tags from the field samples were recovered from salmon heads with the aid of a magnetic field detector. Tags were then decoded with the aid of a Reichert 580 dissecting scope, Hitachi CCTV camera and Koyo video monitor. If no tag was detected, the head was dissolved in a potassium hydroxide solution. A magnet was then stirred through the resultant slurry to recover tags that did not activate the magnetic field detector.

Recovery data for each CWT group were expanded to estimate contribution to the net harvest by time and area. Contribution estimates are the product of actual observed tag codes and an expanded tag factor. The expansion adjusts for that portion of the harvest not sampled, the non-recovery of heads from observed adipose fin-clipped fish and tags lost during dissection. The expanded tag factor varies with each sampling period and is the product of three ratios:

$$(1)\quad \text{Sampling Ratio} = \frac{\text{Estimated Net Harvest}}{\text{Number of Fish Examined for Ad-Clips}}$$

$$(2)\quad \text{Head Recovery Ratio} = \frac{\text{Number of Ad-Clipped Fish Observed}}{\text{Number of Heads Recovered}}$$

$$(3)\quad \text{Lost Tag Ratio} = \frac{\text{Number of Heads with Tags}}{\text{Number of Tags Decoded}}$$

Contribution rates of individual CWT groups to the Indian net fishery were calculated and expressed as a percentage:

$$(4) \quad \text{Contribution Rate (\%)} = \frac{\text{Estimated CWT Harvest}}{\text{Number of Tagged Fish Released}} \times 100$$

The contribution rate compensates for unequal release-size bias and allows for comparison of different release strategies.

Statistical analysis of data was limited to the t-test unless otherwise noted. The data were compared at the 95% confidence level.

RESULTS AND DISCUSSION

A total of 1,133 CWT's were recovered from adipose fin-clipped chinook during the spring and fall net harvest monitoring activities in 1988 (Table 14). These expanded to an estimated 2,540 tagged fall chinook and 366 tagged spring chinook harvested during 1988 by the gill net fishery on the Klamath River portion of the HVR. Adipose fin-clipped chinook that did not contain CWT's composed 11.6% of the sample and expanded to an estimated harvest of 367 adipose fin-clipped chinook that did not contain a CWT and, therefore, could not be assigned to a race or rearing facility. Forty-six tag codes representing various fall chinook release groups were recovered; 25 from IGH stock, 13 from TRH stock, 5 from natural stocks assessment programs, 1 from Mill Creek stock (Trinity River), and 2 from Cole Rivers Hatchery on the Rogue River. Five tag codes representing spring chinook release groups were recovered; 4 from TRH and 1 from Cole Rivers Hatchery.

Fall Chinook

Iron Gate Hatchery stocks accounted for 50.7% of the ad-clipped chinook harvested on the Klamath River portion of the HVR during the fall net harvest monitoring activities in 1988 (Table 15). Trinity River Hatchery accounted for 35.7% (28.2% fall race and 7.5% spring race) of the harvested ad-clipped chinook.

In the Estuary Area, 55.3% of the fall chinook CWT originated from IGH and 22.3% originated from TRH. During the commercial season in the Estuary Area (August 1 through 20), 59.6% of the CWT originated from IGH and 21.6% originated from TRH. In the Middle and Upper Klamath Areas gill net fishery only 36.1% and 33.7% of the CWT originated from IGH while 43.3% and 54.2% originated from TRH. The apparent impact imbalance in the Estuary Area can be attributed to the harvest timing. The Estuary Area was closed on August 25 after the quota was reached and therefore, fishing did not occur over the entire run. Since the early portion of the fall chinook run appears to be dominated by stocks from IGH, the Estuary fishery primarily impacted IGH chinook. It would be expected that CWT chinook in the Middle and Upper Klamath Areas would be caught in proportion to their abundance because these fisheries were allowed to fish throughout the fall run. The impacts on TRH chinook may have been slightly greater than expected in the Middle and Upper Klamath Areas. However, the removal of IGH stocks in the Estuary Area would account for the differences observed in the Middle and Upper Klamath Areas.

TABLE 14. Actual and expanded (underlined) CWT groups recovered during mark sampling of spring and fall chinook salmon in the 1988 gill net fishery on the Klamath River portion of the Hoopa Valley Reservation.

Tag Code	Brood Year	Race	Hatchery[1/] of Origin	Release[2/] Type	RESERVATION MONITORING AREA							
					Estuary		Middle Klamath		Upper Klamath		All Areas	
06-52-02	1984	Fall	IGH[3/]	Y	11	23.73	1	3.74	0	0.00	12	27.48
06-52-04	1985	Fall	HVBC[4/]	Y	0	0.00	1	4.04	0	0.00	1	4.04
06-52-05	1985	Fall	IGH[5/]	Y	44	93.33	6	24.76	9	25.19	59	143.28
06-53-01	1986	Fall	IGH[6/]	Y	0	0.00	0	0.00	2	6.88	2	6.88
06-56-17	1984	Fall	TRH	F[7/]	4	8.42	0	0.00	0	0.00	4	8.42
06-56-18	1984	Fall	TRH	F[7/]	5	11.45	0	0.00	1	1.89	6	13.33
06-56-19	1984	Fall	TRH	F[7/]	11	26.71	2	7.79	0	0.00	13	34.50
06-56-20	1984	Fall	TRH	Y[7/]	5	10.64	1	4.04	5	11.04	11	25.72
06-56-21	1984	Fall	TRH	Y[7/]	3	6.77	3	12.33	4	8.84	10	27.94
06-56-22	1984	Fall	TRH	Y[7/]	15	31.91	2	8.59	4	8.53	21	49.02
06-56-23	1985	Fall	TRH	Y	26	55.71	4	15.57	6	13.15	36	84.43
06-56-24	1984	Fall	TRH	Y+	103	223.95	23	96.91	34	81.62	160	402.48
06-56-25	1985	Fall	TRH	Y	21	58.56	7	25.14	6	17.01	34	100.71
06-56-29	1986	Fall	TRH	F[7/]	0	0.00	1	4.04	0	0.00	1	4.04
06-59-22	1984	Fall	IGH	Y	207	457.70	9	37.22	6	16.18	222	511.10
06-59-23	1983	Fall	IGH	F	3	6.49	0	0.00	0	0.00	3	6.49
06-59-24	1983	Fall	IGH	F[7/]	1	2.22	0	0.00	0	0.00	1	2.22
06-59-25	1983	Fall	IGH	Y	5	10.76	0	0.00	1	2.49	6	13.25
06-59-26	1983	Fall	IGH	Y[7/]	0	0.00	1	6.90	1	1.89	2	8.79
06-59-27	1984	Fall	IGH	F	75	164.58	3	13.86	1	2.49	79	180.93
06-59-28	1984	Fall	IGH	F[7/]	151	345.65	9	33.49	5	14.64	165	393.77
06-59-29	1985	Fall	IGH	Y	11	24.13	1	4.04	2	4.88	14	33.05
06-59-31	1983	Fall	IGH	Y	4	9.23	1	2.91	0	0.00	5	12.14
06-59-32	1983	Fall	IGH	Y	4	8.01	0	0.00	0	0.00	4	8.01
06-59-33	1983	Fall	IGH	Y	3	6.89	0	0.00	0	0.00	3	6.89
06-59-34	1985	Fall	IGH	F	35	79.14	1	3.74	2	4.51	38	87.40
06-59-35	1984	Fall	IGH	Y[7/]	24	54.04	4	16.17	5	10.77	33	80.97
06-61-26	1983	Fall	TRH	F	1	1.93	0	0.00	0	0.00	1	1.93

1/ BCWILD - Wild Stock Assessment Program - Bogus Creek Stock
CRH - Cole Rivers Hatchery - Rogue River
HVBC - Hoopa Valley Business Council
IGH - Iron Gate Hatchery
SRWILD - Wild Stock Assessment Program - Shasta River Stock
TRH - Trinity River Hatchery

2/ F (Fingerling) - May or June release
Y (Yearling) - Late September to December release
Y+ (Yearling-Plus) - February or later release

3/ Reared by Hoopa Valley Business Council and released at Supply Creek - Trinity River

4/ Reared by Hoopa Valley Business Council and released at Tish Tang Creek - Trinity River

5/ Reared by Hoopa Valley Business Council and released at Mill Creek - Trinity River

6/ Reared and released at Cappel Creek - Klamath River

7/ Off-site release

8/ Reared at Fall Creek - Klamath River - released at IGH

TABLE 14. (Continued)
Actual and expanded (underlined) CWT groups recovered during mark sampling of spring and fall chinook salmon in the 1988 gill net fishery on the Klamath River portion of the Hoopa Valley Reservation.

Tag Code	Brood Year	Race	Hatchery[1/] of Origin	Release[2/] Type	RESERVATION MONITORING AREA Estuary		Middle Klamath		Upper Klamath		All Areas	
06-61-27	1984	Fall	TRH	F[7/]	12	30.39	1	3.74	1	2.38	14	36.52
06-61-28	1984	Fall	TRH	Y	26	74.92	1	4.04	6	13.60	33	92.56
06-61-40	1983	Spring	TRH	Y	0	0.00	1	3.74	0	0.00	1	3.74
06-61-42	1985	Spring	TRH	F	11	27.73	1	11.04	1	8.20	13	46.97
06-61-43	1984	Spring	TRH	Y	55	178.07	1	23.50	4	28.80	60	230.37
06-61-44	1985	Spring	TRH	Y	5	31.16	1	11.04	5	40.60	11	82.81
06-63-02	1985	Fall	IGH[8/]	Y	2	4.55	0	0.00	0	0.00	2	4.55
06-63-03	1985	Fall	IGH[8/]	Y	3	6.89	1	4.04	0	0.00	4	10.93
06-63-04	1985	Fall	IGH[8/]	Y	2	4.55	0	0.00	0	0.00	2	4.55
06-63-05	1985	Fall	IGH[8/]	Y	4	9.11	0	0.00	1	2.12	5	11.22
06-63-06	1985	Fall	IGH[8/]	Y	0	0.00	1	4.04	1	1.89	2	5.93
06-63-07	1985	Fall	IGH[8/]	Y	2	3.22	0	0.00	0	0.00	2	3.22
06-63-08	1985	Fall	IGH[8/]	Y	1	2.34	0	0.00	1	1.89	2	4.22
06-63-09	1985	Fall	IGH[8/]	Y	4	9.23	0	0.00	1	2.49	5	11.72
06-63-18	1985	Fall	IGH	Y	6	13.66	0	0.00	0	0.00	6	13.66
07-30-39	1984	Fall	CRH	Y	3	6.65	0	0.00	0	0.00	3	6.65
07-31-38	1984	Spring	CRH	Y	0	0.00	0	0.00	1	6.00	1	6.00
07-35-41	1985	Fall	CRH	Y	2	7.78	0	0.00	0	0.00	2	7.78
B6-08-03	1984	Fall	SRWILD	F	5	11.45	0	0.00	0	0.00	5	11.45
B6-08-04	1984	Fall	BCWILD	F	4	8.42	0	0.00	0	0.00	4	8.42
B6-08-05	1985	Fall	SRWILD	F	0	0.00	1	4.04	0	0.00	1	4.04
B6-08-06	1985	Fall	SRWILD	F	2	3.22	1	3.74	0	0.00	3	6.96
B6-09-02	1984	Fall	BCWILD	F	6	12.85	0	0.00	0	0.00	6	12.85
TOTAL TAGS					927	2168.11	90	398.29	116	339.96	1133	2906.36
AD - NO TAGS					116	255.20	18	76.50	15	35.28	149	366.98
TOTAL					1043	2423.31	108	474.79	131	375.24	1282	3273.34

1/ BCWILD - Wild Stock Assessment Program - Bogus Creek Stock
CRH - Cole Rivers Hatchery - Rogue River
HVBC - Hoopa Valley Business Council
IGH - Iron Gate Hatchery
SRWILD - Wild Stock Assessment Program - Shasta River Stock
TRH - Trinity River Hatchery

2/ F (Fingerling) - May or June release
Y (Yearling) - Late September to December release
Y+ (Yearling-Plus) - February or later release

3/ Reared by Hoopa Valley Business Council and released at Supply Creek - Trinity River

4/ Reared by Hoopa Valley Business Council and released at Tish Tang Creek - Trinity River

5/ Reared by Hoopa Valley Business Council and released at Mill Creek - Trinity River

6/ Reared and released at Cappel Creek - Klamath River

7/ Off-site release

8/ Reared at Fall Creek - Klamath River - released at IGH

TABLE 15. Origin and recovery area of the expanded coded-wire tags harvested by the gill net fishery on the Klamath River portion of the Hoopa Valley Reservation in 1988.

Origin	Recovery Area							
	Estuary		Middle Klamath		Upper Klamath		Total	
Iron Gate Hatchery	1,339.44	(55.3%)	154.92	(36.1%)	98.30	(33.7%)	1,592.66	(50.7%)
Trinity River Hatchery - Fall	541.35	(22.3%)	185.95	(43.3%)	158.05	(54.2%)	885.35	(28.2%)
Trinity River Hatchery - Spring	236.96	(9.8%)	0.00	(0.0%)	0.00	(0.0%)	236.96	(7.5%)
Wild	35.93	(1.5%)	7.79	(1.8%)	0.00	(0.0%)	43.72	(1.4%)
Cole Rivers Hatchery	14.43	(0.6%)	0.00	(0.0%)	0.00	(0.0%)	14.43	(0.5%)
Mill Creek	0.00	(0.0%)	4.04	(0.9%)	0.00	(0.0%)	4.04	(0.1%)
No Tag	255.20	(10.5%)	76.50	(17.8%)	35.28	(12.1%)	366.98	(11.7%)
Total	2,423.31		429.20		291.64		3,144.15	

Age composition of CWT fall chinook harvested in 1988 was 0.4% age 2, 21.4% age 3, 75.9% age 4, and 2.4% age 5. Age composition of CWT fall chinook harvested in the Estuary Area was 0.0% age 2, 19.4% age 3, 78.2% age 4, and 2.4% age 5.

Yearling release groups continue to generally contribute to the gill net fishery at higher rates than other release types (Table 16). Tag code 06-59-28, a fingerling release from IGH, had the highest contribution rate to the gill net fishery of any fingerling release group in previous years and was comparable to that of many yearling release groups.

Mean length, standard deviation and sample sizes by CWT code and area of harvest are presented in Table 17.

Spring Chinook

The increased contribution of CWT spring chinook (Table 18) to a combination of Estuary gill net fishery over the past three years can be attributed to an Estuary gill net fishery in July and the overlap between the run timing of the hatchery's spring and fall chinook stocks (Table 18). In July, 56.6% of the CWT chinook harvest was attributed to TRH spring chinook stock and 27.7% was TRH fall chinook stock. In years prior to 1985, the harvest estimates for the Estuary fishery in June and July were generally near zero.

TABLE 16. Contribution rate of CWT age 3 and 4 fall chinook to the Indian net fishery on the Klamath River portion of the Hoopa Valley Reservation.

Tag Code	Brood Year	Rearing[1] Facility	Release[2] Type	NUMBER HARVESTED[3] 3	4	Total	Number[4] Released Tagged	Contribution[5] Rate
06-56-08	1983	TRH	F[6]	25	25	50	91,153	.055
06-56-12	1983	TRH	F[6]	80	18	98	97,311	.101
06-56-13	1983	TRH	F[6]	105	26	131	100,227	.131
06-56-14	1983	TRH	Y[6]	0	18	18	25,547	.071
06-56-15	1983	TRH	Y[6]	26	15	41	25,754	.159
06-56-16	1983	TRH	Y[6]	0	17	17	26,171	.065
06-59-23	1983	IGH	F	38	158	196	191,352	.102
06-59-24	1983	IGH	F[6]	80	92	172	97,566	.176
06-59-25	1983	IGH	Y	25	903	928	94,738	.980
06-59-26	1983	IGH	Y	34	291	325	23,725	1.370
06-59-31	1983	IGH	Y	0	173	173	22,599	.766
06-59-32	1983	IGH	Y	10	185	195	24,830	.785
06-59-33	1983	IGH	Y	0	257	257	23,766	1.081
06-61-13	1983	TRH	Y	62	143	205	100,520	.204
06-61-26	1983	TRH	F	87	35	122	191,094	.064
06-63-01	1983	TRH	Y+	13	298	311	92,965	.335
06-52-02	1984	HVBC	Y	2	27	29	1,909	1.519
06-56-17	1984	TRH	F[6]	37	8	45	98,906	.045
06-56-18	1984	TRH	F[6]	39	13	52	98,989	.053
06-56-19	1984	TRH	F[6]	63	35	98	94,100	.104
06-56-20	1984	TRH	Y[6]	42	26	68	30,459	.223
06-56-21	1984	TRH	Y[6]	15	28	43	24,541	.175
06-56-22	1984	TRH	Y[6]	9	49	58	25,450	.228
06-56-24	1984	TRH	Y+	86	402	488	102,512	.476
06-59-22	1984	IGH	Y	53	511	564	98,500	.573
06-59-27	1984	IGH	F	37	181	218	187,500	.116
06-59-28	1984	IGH	F	130	394	524	93,710	.559
06-59-35	1984	IGH	Y[6]	5	81	86	24,275	.354
06-61-27	1984	TRH	F	135	37	172	189,708	.091
06-61-28	1984	TRH	Y	36	93	129	97,070	.133
06-52-04	1985	HVBC	Y	4	-	4	3,706	.108
06-52-05	1985	IGH	Y	143	-	143	26,505	.540
06-56-23	1985	TRH	Y	84	-	84	196,249	.043
06-56-25	1985	TRH	Y	101	-	101	97,368	.104
06-59-29	1985	IGH	Y	33	-	33	95,296	.035
06-59-34	1985	IGH	F	87	-	87	147,356	.059
06-63-02	1985	IGH[7]	Y	5	-	5	15,720	.032
06-63-03	1985	IGH[7]	Y	11	-	11	18,875	.058
06-63-04	1985	IGH[7]	Y	5	-	5	16,038	.031
06-63-05	1985	IGH[7]	Y	11	-	11	16,038	.069
06-63-06	1985	IGH[7]	Y	6	-	6	21,225	.028
06-63-07	1985	IGH[7]	Y	3	-	3	21,225	.014
06-63-08	1985	IGH[7]	Y	4	-	4	18,126	.022
06-63-09	1985	IGH[7]	Y	12	-	12	17,596	.068
06-63-18	1985	IGH	Y	14	-	14	24,443	.057
86-08-05	1985	SRWILD	F	4	-	4	23,568	.017
86-08-06	1985	SRWILD	F	7	-	7	26,857	.026

1/ IGH - Iron Gate Hatchery

TRH - Trinity River Hatchery

HVBC - Hoopa Valley Business Council Hatchery

SRWILD - Wild Stock Assessment Program - Shasta River Stock

2/ F (Fingerling) - May or June release

Y (Yearling) - Late September to November release

Y+ (Yearling-Plus) - February release

3/ Estimated number of coded-wire tagged fall chinook

4/ From Pacific Marine Fisheries Commission CWT release data (PMFC 1988)

5/ Contribution rate = estimated number harvested / number released tagged X 100

6/ Off-site release

7/ Reared at Fall Creek - Klamath River - Released at IGH

TABLE 17. Mean fork length, standard deviation and number of recoveries for 51 spring and fall chinook coded wire tag release groups harvested on the Klamath River portion of the Hoopa Valley Reservation in 1988. Footnotes appear on 3rd page of table.

Tag Code	Brood Year	Race	Hatchery[1/] of Origin	Release[2/] Type	RESERVATION MONITORING AREA Estuary	Middle Klamath	Upper Klamath	All Areas
06-59-23	1983	Fall	IGH	F	81.7[3/]	---	---	81.7
					4.7[4/]	---	---	4.7
					3 [5/]	0	0	3
06-59-24	1983	Fall	IGH	F[6/]	79.0	---	---	79.0
					---	---	---	---
					1	0	0	1
06-59-25	1983	Fall	IGH	Y	88.2	---	89.0	88.3
					9.1	---	---	8.1
					5	0	1	6
06-59-26	1983	Fall	IGH	Y[6/]	---	92.0	70.0	81.0
					---	---	---	15.6
					0	1	1	2
06-59-31	1983	Fall	IGH	Y	88.0	87.0	---	87.8
					5.9	---	---	5.2
					4	1	0	5
06-59-32	1983	Fall	IGH	Y	85.8	---	---	85.8
					3.0	---	---	3.0
					4	0	0	4
06-59-33	1983	Fall	IGH	Y	82.7	---	---	82.7
					3.2	---	---	3.2
					3	0	0	3
06-61-26	1983	Fall	TRH	F	85.0	---	---	85.0
					---	---	---	---
					1	0	0	1
06-61-40	1983	Spring	TRH	Y	---	88.0	---	88.0
					---	---	---	---
					0	1	0	1
06-52-02	1984	Fall	IGH	Y[7/]	82.2	77.0	---	81.8
					6.1	---	---	6.0
					11	1	0	12
06-56-17	1984	Fall	TRH	F[6/]	76.5	---	---	76.5
					4.1	---	---	4.1
					4	0	0	4
06-56-18	1984	Fall	TRH	F[6/]	77.6	---	78.0	77.7
					4.7	---	---	4.2
					5	0	1	6
06-56-19	1984	Fall	TRH	F[6/]	77.4	83.0	---	78.2
					5.2	1.4	---	5.2
					11	2	0	13
06-56-20	1984	Fall	TRH	Y[6/]	75.2	75.0	73.2	74.3
					4.9	---	2.2	3.6
					5	1	5	11
06-56-21	1984	Fall	TRH	Y[6/]	78.0	77.7	77.5	77.7
					3.6	2.9	3.1	2.8
					3	3	4	10
06-56-22	1984	Fall	TRH	Y[6/]	76.6	73.0	74.5	75.9
					4.5	1.4	5.3	4.5
					15	2	4	21
06-56-24	1984	Fall	TRH	Y+	75.9	74.3	75.1	75.5
					3.5	3.2	3.6	3.5
					103	23	34	160
06-59-22	1984	Fall	IGH	Y	78.8	82.2	76.8	78.9
					5.1	6.2	2.5	5.1
					207	9	6	222
06-59-27	1984	Fall	IGH	F	79.4	81.7	90.0	79.6
					5.3	8.0	---	5.5
					75	3	1	79

TABLE 17. (Continued)
Mean fork length, standard deviation and number of recoveries for 51 spring and fall chinook coded wire tag release groups harvested on the Klamath River portion of the Hoopa Valley Reservation in 1988. Footnotes appear on 3rd page of table.

Tag Code	Brood Year	Race	Hatchery[1/] of Origin	Release[2/] Type	RESERVATION MONITORING AREA Estuary	Middle Klamath	Upper Klamath	All Areas
06-59-28	1984	Fall	IGH	F[6/]	80.7 5.7 151	82.0 6.7 9	80.4 4.6 5	80.8 5.7 165
06-59-35	1984	Fall	IGH	Y[6/]	78.0 3.4 24	81.3 4.7 4	79.4 5.0 5	78.6 3.9 33
06-61-27	1984	Fall	TRH	F[6/]	78.3 4.6 12	76.0 --- 1	70.0 --- 1	77.5 4.8 14
06-61-28	1984	Fall	TRH	Y	75.9 5.2 26	69.0 --- 1	79.7 5.5 6	76.4 5.5 33
06-61-43	1984	Spring	TRH	Y	74.9 3.9 55	70.0 --- 1	73.3 2.5 4	74.7 3.8 60
07-30-39	1984	Fall	CRH	Y	79.7 7.6 3	--- --- 0	--- --- 0	79.7 7.6 3
07-31-38	1984	Spring	CRH	Y	--- --- 0	--- --- 0	67.0 --- 1	67.0 --- 1
B6-08-03	1984	Fall	SRWILD	F	73.6 6.6 5	--- --- 0	--- --- 0	73.6 6.6 5
B6-08-04	1984	Fall	BCWILD	F	80.3 4.4 4	--- --- 0	--- --- 0	80.3 4.4 4
B6-09-02	1984	Fall	BCWILD	F	76.5 9.8 6	--- --- 0	--- --- 0	76.5 9.8 6
06-52-04	1985	Fall	HVBC	Y	--- --- 0	66.0 --- 1	--- --- 0	66.0 --- 1
06-52-05	1985	Fall	IGH[8/]	Y	72.0 4.1 44	72.3 6.2 6	73.7 2.6 9	72.3 4.1 59
06-56-23	1985	Fall	TRH	Y	72.7 5.0 26	68.8 3.1 4	76.0 6.2 6	72.8 5.3 36
06-56-25	1985	Fall	TRH	Y	68.1 3.5 21	67.7 3.3 7	68.7 5.1 6	68.1 3.7 34
06-59-29	1985	Fall	IGH	Y	70.8 3.4 11	71.0 --- 1	69.5 3.5 2	70.6 3.2 14
06-59-34	1985	Fall	IGH	F	76.2 4.7 35	79.0 --- 1	79.0 0.0 2	76.4 4.6 38
06-61-42	1985	Spring	TRH	F	73.3 5.4 11	77.0 --- 1	66.0 --- 1	73.0 5.5 13
06-61-44	1985	Spring	TRH	Y	69.2 4.4 5	61.0 --- 1	67.8 4.5 5	67.8 4.6 11
06-63-02	1985	Fall	IGH	Y	71.5 3.5 2	--- --- 0	--- --- 0	71.5 3.5 2

TABLE 17. (Continued)
Mean fork length, standard deviation and number of recoveries for 51 spring and fall chinook coded wire tag release groups harvested on the Klamath River portion of the Hoopa Valley Reservation in 1988. Footnotes appear on 3rd page of table.

					RESERVATION MONITORING AREA			
Tag Code	Brood Year	Race	Hatchery[1/] of Origin	Release[2/] Type	Estuary	Middle Klamath	Upper Klamath	All Areas
06-63-03	1985	Fall	IGH	Y	70.3 10.4 3	82.0 --- 1	--- --- 0	73.3 10.3 4
06-63-04	1985	Fall	IGH	Y	72.0 5.7 2	--- --- 0	--- --- 0	72.0 5.7 2
06-63-05	1985	Fall	IGH	Y	72.3 4.3 4	--- --- 0	73.0 --- 1	72.4 3.7 5
06-63-06	1985	Fall	IGH	Y	--- --- 0	68.0 --- 1	69.0 --- 1	68.5 0.7 2
06-63-07	1985	Fall	IGH	Y	79.5 0.7 2	--- --- 0	--- --- 0	79.5 0.7 2
06-63-08	1985	Fall	IGH	Y	73.0 --- 1	--- --- 0	75.0 --- 1	74.0 1.4 2
06-63-09	1985	Fall	IGH	Y	72.8 4.9 4	--- --- 0	65.0 --- 1	71.2 5.5 5
06-63-18	1985	Fall	IGH	Y	72.8 4.2 6	--- --- 0	--- --- 0	72.8 4.2 6
07-35-41	1985	Fall	CRH	Y	83.5 16.3 2	--- --- 0	--- --- 0	83.5 16.3 2
B6-08-05	1985	Fall	SRWILD	F	--- --- 0	82.0 --- 1	--- --- 0	82.0 --- 1
B6-08-06	1985	Fall	SRWILD	F	74.5 3.5 2	79.0 --- 1	--- --- 0	76.0 3.6 3
06-53-01	1986	Fall	Cappel	Y	--- --- 0	--- --- 0	47.5 3.5 2	47.5 3.5 2
06-56-29	1986	Fall	TRH	F[6/]	--- --- 0	50.0 --- 1	--- --- 0	50.0 --- 1

1/ BCWILD - Wild Stock Assessment Program - Bogus Creek
CRH - Cole Rivers Hatchery
HVBC - Hoopa Valley Business Council
IGH - Iron Gate Hatchery
RRH - Rocky Reach Hatchery - Columbia River
SRWILD - Wild Stock Assessment Program - Shasta River
TRH - Trinity River Hatchery

2/ F (Fingerling) - May or June release
Y (Yearling) - Late September to December release
Y+ (Yearling-Plus) - February or later release

3/ Mean fork length (cm)

4/ Standard deviation

5/ Number in sample

6/ Off-site release

7/ Reared and released at Supply Creek - Trinity River

8/ Reared and released at Tish Tang Creek - Trinity River

TABLE 18. Contribution rate of CWT age 3 and 4 spring chinook for brood years 1978-1985 to the gill net fishery on the Klamath River portion of the Hoopa Valley Reservation.

Tag Code	Brood Year	Rearing[1/] Facility	Release[2/] Type	NUMBER HARVESTED[3/] 3	4	Total	Number[4/] Released Tagged	Contribution[5/] Rate
06-61-11	1978	TRH	F[6/]	163	47	210	192,800	0.109
06-61-12	1978	TRH	F	69	11	80	170,800	0.047
06-61-30	1978	TRH	Y	126	541	667	191,916	0.348
06-61-31	1978	TRH	Y+	25	351	376	134,948	0.279
06-61-32	1979	TRH	F	0	15	15	187,494	0.008
06-61-33	1979	TRH	F[6/]	40	73	113	181,134	0.062
06-61-34	1979	TRH	Y	44	30	73	86,594	0.084
06-61-36	1979	TRH	Y+	0	10	10	35,666	0.028
06-61-39	1980	TRH	Y	10	39	49	34,601	0.142
06-61-35	1981	TRH	F	0	0	0	182,635	0.000
06-61-37	1981	TRH	Y	9	73	82	98,637	0.083
06-61-38	1982	TRH	Y	76	50	126	96,461	0.131
06-61-41	1982	TRH	F	6	12	18	146,194	0.012
06-61-40	1983	TRH	Y	96	224	320	90,293	0.354
06-61-43	1984	TRH	Y	207	230	437	98,568	0.443
06-61-42	1985	TRH	Y	47	-	47	192,487	0.024
06-61-44	1985	TRH	Y	83	-	83	101,091	0.082

1/ TRH - Trinity River Hatchery

2/ F (Fingerling) - May or June release
Y (Yearling) - Late September to November release
Y+ (Yearling-Plus) - March release

3/ Estimated number of coded-wire tagged spring chinook

4/ From Pacific Marine Fisheries Commission CWT release data (PMFC 1985)

5/ Contribution rate = number harvested / number released tagged X 100

6/ Off-site release at Trinity River kilometer 40.0 (Willow Creek)

HARVEST OVERVIEW

INTRODUCTION

The presentation of fall chinook harvest levels occurring in the Indian gill net fishery describes only one component of the fishing impacts sustained by Klamath River fall chinook. To provide a broader view, data from the other fisheries harvesting Klamath River fall chinook are presented. Because of the impacts these fisheries have on the naturally spawning chinook, the natural and hatchery fall chinook population trends and the effectiveness of the present management strategies to protect naturally spawning fall chinook are also discussed.

The following analysis concerns adult fall chinook data only. The reader is advised to employ discretion when making comparisons with analysis presented in previous reports since methodologies have changed and data has been updated.

DISCUSSION

The 1988 season for the various ocean and inland fisheries were shaped following recommendations by the KFMC concerning allowable harvest levels. Under the proposed harvest rates, 35% of the natural adult fall chinook population would escape the ocean and in-river fisheries. By allowing 35% escapement, the Klamath population will reach maximum sustained yield and provide escapement sufficient to determine the stock-recruit relation. The recommendation of the KFMC allowed a harvest rate of 0.325 in the ocean and 0.525 in river on fully vulnerable 4 and 5 year old Klamath River fall chinook. Age 3 chinook would be harvested at a lower rate because of size limits and gear selectivity. The actual ocean harvest rate in 1988 was approximately 0.48. Total commercial and ocean sport chinook landings approached record levels in the area between Fort Bragg, California and Coos Bay, Oregon (Table 19). In 1988, 206,100 Klamath River fall chinook were caught as compared to 325,20 in 1987. An in river harvest rate of 0.46 was achieved in 1988 which translated into a combined harvest of 67,500 fall chinook by Indian and sport fishers. A decline in the spawning escapement was observed compared to the previous two years but was still considerably greater than the years prior to 1985 (Table 19). The combined harvest rate of ocean and in-river fisheries (0.69) slightly exceeded the target harvest rate of 0.65.

Over the last four years, the average overall harvest rate has been 0.62, which, from a biological view, means the fisheries have been controlled to allow adequate escapement. However, from a users view, harvest has still not achieved the agreed on allocation; The ocean harvest exceeded the agreed harvest rate while the in-river fisheries did not reach the agreed harvest rate. Much of the problem lies in the biologists ability to accurately predict the preseason abundance of Klamath stock size, the ocean distribution of Klamath stock and the effects of various closures on the ocean fisheries.

A combination of factors have hindered the accurate prediction of Klamath stock abundance. The primary factor lies in the stock abundance itself. For the return year 1979-1985, the average ocean population of 3 and 4-year-old Klamath River fall chinook was 210,700. During the 1986-1988 return years, the

TABLE 19. Estimated contribution of Klamath River adult fall chinook to the ocean and in-river fisheries from 1981-1988 (in thousands).

Year	Ocean[1/] Troll Landing	Ocean[1/] Sport Landing	Klamath[2/] Ocean Catch	In-River Run Size	In-River Sport Catch	In-River Gillnet Catch	Total Spawning Escapement	% of Klamath Catch Harvested In-River
1981	408.6	23.2	129.5	77.3	6.0	33.0	38.3	23.1
1982	525.4	41.6	170.1	65.2	8.3	14.5	42.4	11.8
1983	157.5	30.0	56.3	56.7	4.2	7.9	44.6	17.7
1984	118.1	23.0	42.3	45.6	3.3	18.7	23.6	34.2
1985	316.0	94.7	123.2	63.4	3.6	11.6	48.2	11.0
1986	615.5	44.6	336.2	192.4	21.0	25.1	146.3	12.1
1987	819.4	84.4	325.2	204.1	20.2	53.1	130.8	18.4
1988	785.8	70.7	206.1	181.1	15.8	51.7	113.6	24.7

1/ Landings between Ft. Bragg, California and Coos Bay, Oregon

2/ Prior to 1986, the ocean contribution of Klamath fall chinook was assumed to be 30%. 1986 throuth 1988 ocean contribution rates were calculated based on coded-wire tag information, unpublished material from the KRTT, 1989.

average ocean population of 3 and 4-year-old fall chinook tripled to 654,900, which was far outside the data base used to predict abundance. This caused a substantial underprediction of abundance. Since the ocean fisheries were managed under a combination of seasonal and quota management, the areas with seasonal management were able to respond to the actual abundance and record landings of chinook were observed. Areas with quota management quickly filled their quota and fishing ceased. But again, the ocean as a whole achieved near record landings. Harvest rates have also exceeded expectations. Under the Klamath agreements, the ocean agreed to a harvest rate of 0.30 in 1986 and 0.325 in 1987 and 1988 on fully vulnerable 4 and 5-year-old fall chinook. Actual harvest rates were 0.47, 0.55 and 0.48 from 1986-1988 respectively. The ocean fisheries exceeded the agreed upon harvest rate primarily because of limitations within the available data base. These data affect the biologists ability to predict the effects of various closures on catch and the ocean distribution of Klamath stocks. As more data becomes available, these predictions will improve, although, variability in stock distribution will always cause some inaccuracy in stock prediction. The in-river fisheries on the other hand are managed primarily by quota. Since the quota was based on the preseason projection of in-river run size, which was underestimated, the harvest rate achieved by the in-river fisheries has been substantially less than would have been allowed if the predictions had been accurate. The harvest agreements allowed harvest rates of 0.50 in 1986 and 0.525 in 1987 and 1988. The actual harvest rate were 0.34, 0.42 and 0.46 from 1986 to 1988 respectively. Had the in-river fisheries achieved the agreed to harvest rate, the combined ocean and in-river harvest rate would have significantly exceeded the target of 65%. The stated goal of allowing 35% of the natural stock to escape the ocean and in-river fisheries would not have been achieved.

While the overall escapement rate has averaged 38% over the last three years and it appears the fall chinook stocks in the basin have benefited from the harvest agreements, there is still much concern for the health of the natural stocks. One problem is defining a natural spawner. For this discussion, a natural spawner is defined as the progeny of a fish that has spawned in the wild. Therefore, a fish that was raised in a hatchery or other artificial setting as a juvenile and then returns to spawn in the wild is not a natural spawner; however, the progeny of those spawners would be classified as naturally produced fish. By examining five major spawning tributaries to the Klamath River, several population trends were evident. Bogus Creek, the tributary immediately adjacent to Iron Gate Hatchery, and the Trinity River have experienced phenomenal returns in recent years (Table 20). Unfortunately, many of the spawners are hatchery strays. Because of the close proximity to Iron Gate Hatchery, Bogus Creek will always have a large hatchery component straying into the watershed. However, care must be taken when using spawning escapement information from Bogus Creek and the Trinity River to estimate natural chinook escapement. Biologically, overescapement has occurred in Bogus Creek which has probably reduced the actual juvenile production from the stream. Chinook superimpose redds upon one another destroying the earlier spawning attempts of other chinook and reducing the effective number of resulting juveniles. The Trinity River has also been overescaped within two miles of the hatchery while the remaining areas have not approached full escapement. The natural chinook also interbreed with hatchery stocks which affects genetic variability. The problem arises in calling all of these fish natural spawners. For example, in 1987, 71,920 adult fall chinook were attributed to natural spawning in the Trinity River (CDFG 1988). However, using differences in ad-clip rates at the hatchery (21.8%) and at the Willow Creek weir (19.4%), the natural component

TABLE 20. Adult fall chinook returns to four tributaries of the Klamath River from 1978-1988.[1/]

Year	Scott River	Shasta River	Bogus Creek	Salmon River
1978	3,423	12,024	4,928	2,600
1979	3,396	7,111	5,444	1,000
1980	2,032	3,762	3,321	800
1981	3,147	7,890	2,730	750
1982	5,826	6,533	4,818	1,000
1983	3,398	3,119	2,713	1,200
1984	1,443	2,362	3,039	1,226
1985	3,051	2,897	3,491	2,259
1986	3,176	3,274	6,124	2,716
1987	7,769	4,299	9,748	3,832
1988	4,727	2,586	16,215	3,273
Mean	3,763	5,078	5,688	1,878

1/ All estimates from CDFG.

was only 8000 adult fall chinook or 11% of the Trinity River run size. What appears on paper are incredible increases in natural spawning escapement which could suggest fishing seasons and harvest rates should be liberalized. One of the problems of managing for natural stocks is that hatcheries will respond quickly to harvest regulations and will result in overescapement. Tributaries that are solely supported by natural stock could not support harvest rates that the hatchery and Bogus Creek could sustain.

In contrast to Bogus Creek and Trinity River, the spawning escapement to the Shasta and Scott Rivers is predominately of natural origin. However, spawning escapement to the Shasta River has been stable over the last several years while the spawning escapement to the Klamath Basin has increased. Escapement to the Scott River has fluctuated over the last few years but not to the extent to reflect increased escapement to the Klamath as a whole. Spawning information from the Shasta and Scott Rivers must be treated with caution because they have major water diversions that have degraded spawning and rearing habitat. Habitat degradation has masked any influence harvest restrictions may have had on the spawning populations. In effect, habitat degradation has decreased the productivity of these two rivers. Some supplemental rearing of juvenile chinook has occurred on the Scott River, but artificial propagation will only serve to postpone dealing with the real problems in the watershed; particularly water diversion. Any increase in the number of spawners would do little to increase the juvenile production from these rivers. Either river would be a poor indicator of natural production.

The Salmon River is probably the best indicator of natural stock strengths and the effects of regulating harvest since it is isolated from major hatchery interactions and has no major water diversions to degrade the habitat. The Salmon River watershed has been and continues to be logged, but logging impacts are common through out northern California and should not have anymore or less impacts on the Salmon river than on other Klamath River tributaries. In general, the spawning escapement has increased over the last several years although not to the extent returns to the hatchery have increased. The preliminary judgement suggest that harvest rate management has effected an increase in natural production. The average adult fall chinook escapement to the Salmon River from 1978 to 1985 was 1354. During the period harvest rate management was in effect, the escapement has ranged from 2716 to 3832 adult fall chinook (Figure 20). How these escapement relate to the carrying capacity of the Salmon River or the Klamath Basin is unknown at this time. But the purpose of harvest rate management is to allow sufficient escapement that the carrying capacity can be determined (KRTT 1986). The KRTT (1986) cautions that deviation from harvest rate management should not occur until an accurate spawner-recruit relationship has been developed. However, during the 1989 PFMC season setting process, the PFMC attempted to deviate from harvest rate management by considering optimum yield. Because of the rigidity of the Framework Plan Amendment, the PFMC was bound to allow approximately 35% of the natural Klamath River stock to escape the ocean and in-river fisheries. In 1989, the PFMC is scheduled to consider altering the Framework Plan Amendment which would allow the council to deviate from harvest rate management. Deviations from the 35% escapement goal will hinder the necessary data gathering that is required to define the spawner-recruit relationship. Short term gains in the number of chinook harvested will actually translate into a net loss for the fisheries and the natural stocks. By maintaining harvest rate management, the long term yield will exceed the yield generated from lower escapement rates. In addition, naturally spawning fall chinook will be protected, which is important since these fish provide the genetic diversity that will maintain the stock through periods of adverse environmental conditions.

COHO SALMON, STEELHEAD TROUT, STURGEON AND SHAD INVESTIGATIONS

INTRODUCTION

The 1988 coho salmon, steelhead trout, sturgeon and American shad (Alosa sapidissima) runs in the Klamath River were sampled through the previously described beach seining and net harvest monitoring programs. The seining operation targets fall chinook salmon during their migration period. However, incidental species such as coho salmon, steelhead trout, sturgeon and American shad occurred in the catch; often in significant numbers. Coho and steelhead are not target species for the Indian net fishery and their harvest is generally considered incidental to that of spring and fall chinook salmon and sturgeon. The data collected from these species may not be representative of their various life histories. Descriptive statistics are presented for informative purposes only.

METHODS

Methods used in collecting and analyzing beach seine and net harvest data for coho, steelhead and sturgeon are the same as previously described for chinook salmon. In addition, sturgeon were measured to total length and implanted with Peterson disk tags. Statistical analysis of data was limited to the t-test unless otherwise noted. The data were compared at the 95% confidence level.

RESULTS AND DISCUSSION

Coho Salmon

Beach Seining

During the 1988 field season, 19 coho were captured in the beach seine. Scales were collected from 17 coho and all coho aged were three years old. Ad-clipped coho comprised 5.9% of the sample. The mean fork length was 63.9 cm and ranged from 57 cm to 71 cm (Figure 14). The mean weight from 4 coho was 4.7 kg. The first coho was captured on September 1, 1988. Spaghetti tags were applied to 17 coho and no tags were recovered.

The relatively few coho captured in 1988 may be explained by the coho run timing and the duration of the beach seining operation which ended on September 26, 1988. In 1987, only 16 were captured by September 22. However, by October 6, a total of 115 coho had been captured. More coho would have been caught in 1988 had seining continued.

Net Harvest

An estimated 588 coho salmon, 15 jacks (<56 cm) and 573 adults, were harvested by the gill net fishery on the Klamath River portion of the HVR in 1988 (Table 21). The majority of the coho (64.5%) were harvested in the Upper Klamath Area. Peak weekly harvest in both the Middle and Upper Klamath Areas occurred October 9 through 15.

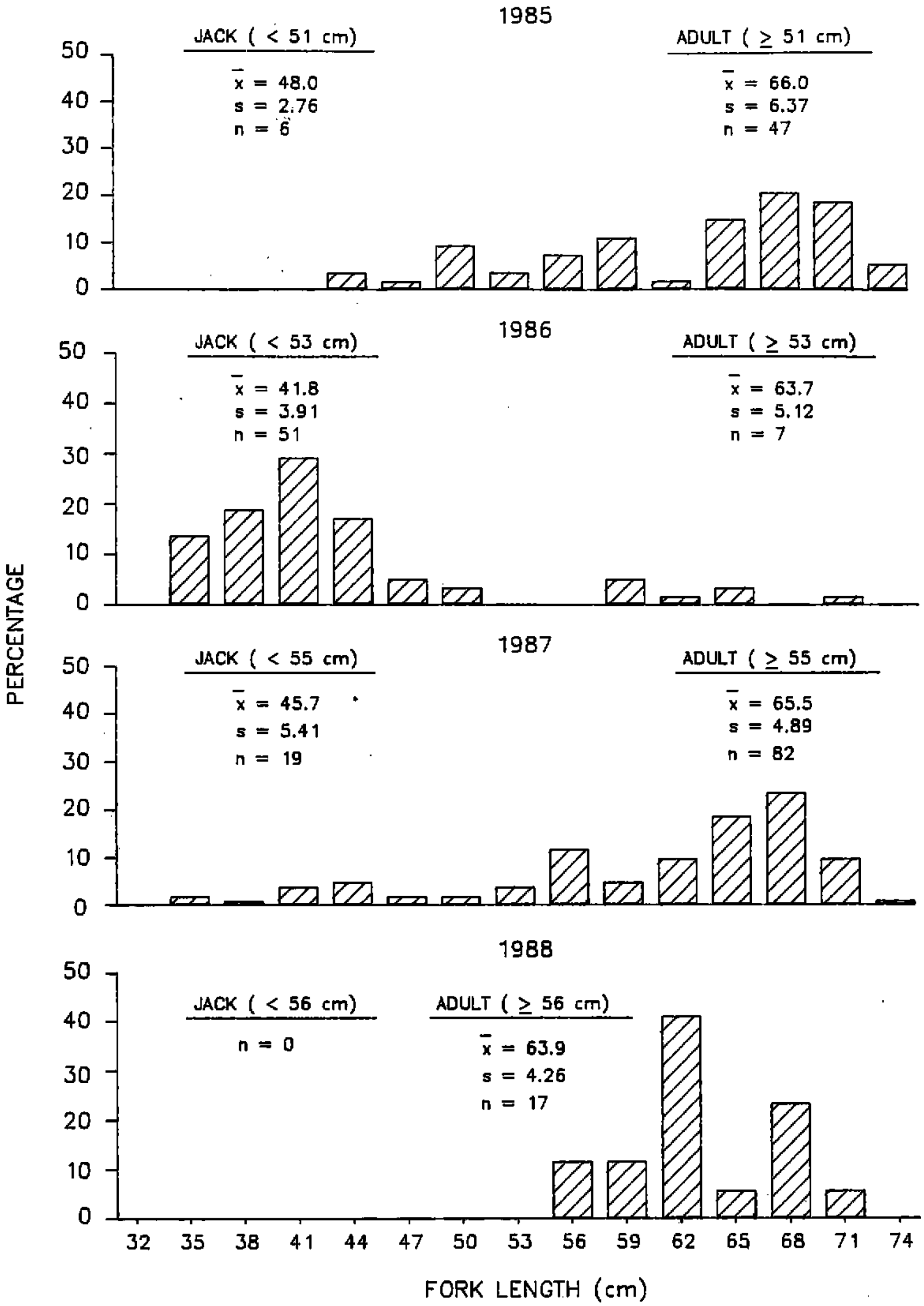

Figure 14. Length frequency distributions of coho salmon captured during beach seine operations in the Klamath River estuary during 1985-1988.

TABLE 21. Semi-monthly estimates of coho salmon harvest by the gill net fishery on the Klamath River portion of the Hoopa Valley Reservation in 1988.

Time Period		NET HARVEST MONITORING AREA Estuary	Middle Klamath	Upper Klamath	Semi-Monthly Total (All Areas)	Cumulative Seasonal Total
Aug.	1-15	5	0	0	5	5
	16-31	0	0	0	0	5
Sept.	1-15	0	0	0	0	5
	16-30	0	17	36	53	58
Oct.	1-15	0	162	263	425	483
	16-31	0	25	80	105	588
TOTAL		5	204	379	588	

Mean length of adult coho, 69.3 cm, was significantly smaller ($p<0.05$) than that of adult coho harvested in 1985 and 1986, but not significantly different ($p>0.05$) from 1987 adults (Figure 15). Mean length of coho jacks, 46.8 cm was not significantly different ($p>0.05$) than mean lengths of coho jacks harvested in 1985-1987.

Seven (3.2%) of the 216 coho mark sampled were ad-clipped. One CWT (06-56-54) was recovered and expanded out to an estimated harvest of 2 coho salmon with this code. Six ad-clipped coho did not contain a CWT and expanded to an estimated harvest of 13. Coho salmon harvest estimates for the Hoopa Valley Reseration from 1977 to 1988 are summarized in Table 22.

Steelhead Trout

Beach Seining

From July 18 to September 22, 1988, 520 steelhead were captured. Length statistics were obtained from 56 "half-pounders" (<43 cm) and 176 adults. The mean length of half-pounders was 36.8 cm and of adults was 49.9 cm (Figure 16). In comparison with previous seasons, mean length of 1988 half-pounders did not significantly differ ($p>0.05$) from 1987 and 1986 half-pounders but were significantly smaller ($p<0.05$) than 1985 half-pounders. Adult steelhead were significantly smaller ($p<0.05$) than 1987 and 1985 adults but were not significantly different ($p>0.05$) from the 1986 adults.

The peak weekly catch (218) of steelhead occurred from September 5 through 9, 1988. The highest daily catch (106) was on September 19.

Net Harvest

An estimated 399 steelhead trout, 36 half-pounders (<42 cm) and 363 adults, were harvested by the gill net fishery on the Klamath River portion of the HVR during August through October in 1988 (Table 23).

Mean fork lengths of adult (57.1 cm) and half-pounder (35.0 cm) steelhead did not significantly differ ($p>0.05$) from those of steelhead harvested in 1985 through 1987 (Figure 17). Steelhead trout harvest estimates for the Hoopa Valley Reservation from 1977 to 1988 are summarized in Table 24.

Sturgeon

Beach Seining

During the 1988 seining operation, one green and one white sturgeon were captured. The green sturgeon measured 56 cm total length and the white sturgeon was 83 cm total length. Peterson-type disc tags were applied to both sturgeon. White sturgeon are seldom encountered in the seining operation. Prior to this season, one adult white sturgeon was captured during 1987 and two others in 1983.

Net Harvest

An estimated 212 green sturgeon, 5 juveniles (<130 cm) and 207 adults, were harvested by the gill net fishery on the Klamath River portion of the HVR in 1988 (Table 25). An estimated 5 white sturgeon were harvested in 1988. The

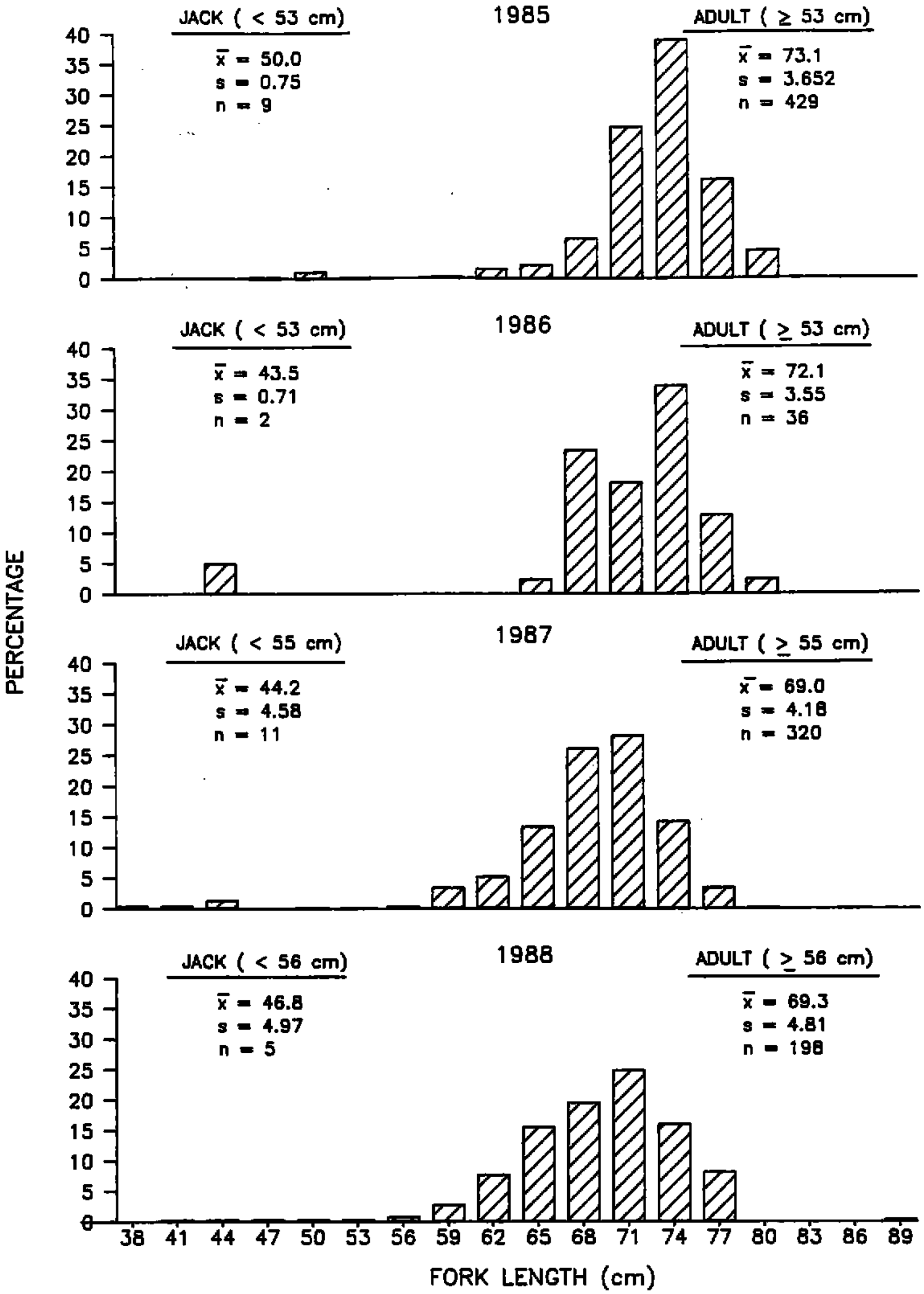

Figure 15. Length frequency distributions of coho salmon harvested by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1985-1988.

TABLE 22. Final estimates of coho salmon harvest by the gill net fishery on the Hoopa Valley Reservation during 1980-1988 1/.

Year	COHO Jacks	Adults	Total
1980	-	-	1,500
1981	163	1,470	1,633
1982	49	951	1,000
1983	4	121	125
1984	261	738	999
1985	119	3,009	3,128
1986	24	248	272
1987	31	1,517	1,548
1988	15	817	832

1/ Estimates for 1983-1988 Trinity River net fishery were obtained from the Hoopa Valley Business Council, Fisheries Department. All other harvest estimated by the Fish and Wildlife Service by methods described in previous annual reports.

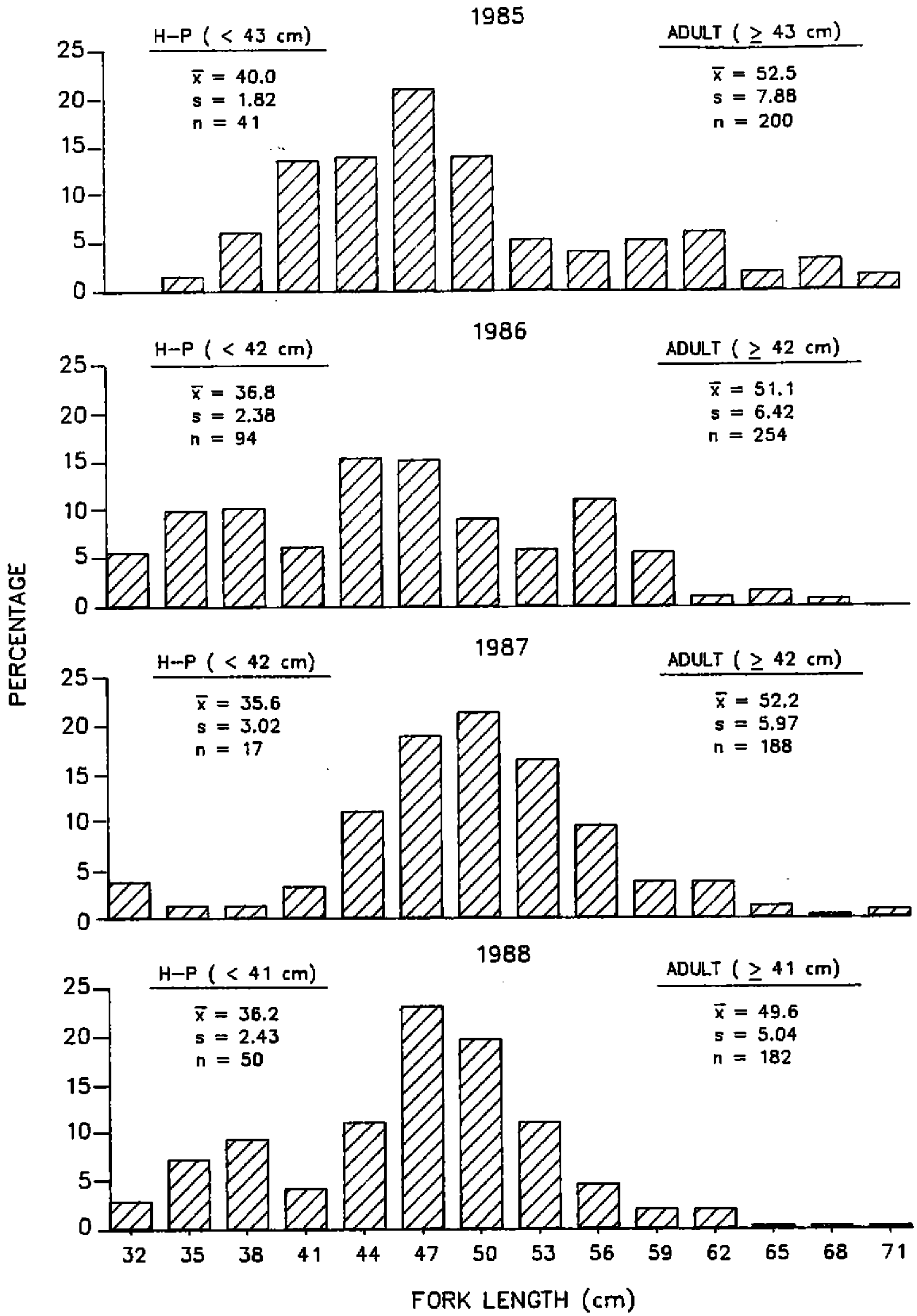

Figure 16. Length frequency distributions of steelhead trout captured during beach seine operations in the Klamath River estuary during 1985-1988.

TABLE 23. Semi-monthly estimates of steelhead trout harvest by the gill net fishery on the Klamath River portion of the Hoopa Valley Reservation in 1988.

Time Period		NET HARVEST MONITORING AREA Estuary	Middle Klamath	Upper Klamath	Semi-Monthly Total (All Areas)	Cumulative Seasonal Total
Aug.	1-15	47	0	2	49	49
	16-31	79	36	30	145	194
Sept.	1-15	0	68	23	91	285
	16-30	0	35	36	71	356
Oct.	1-15	0	11	20	31	387
	16-31	0	0	12	12	399
TOTAL		126	150	123	399	

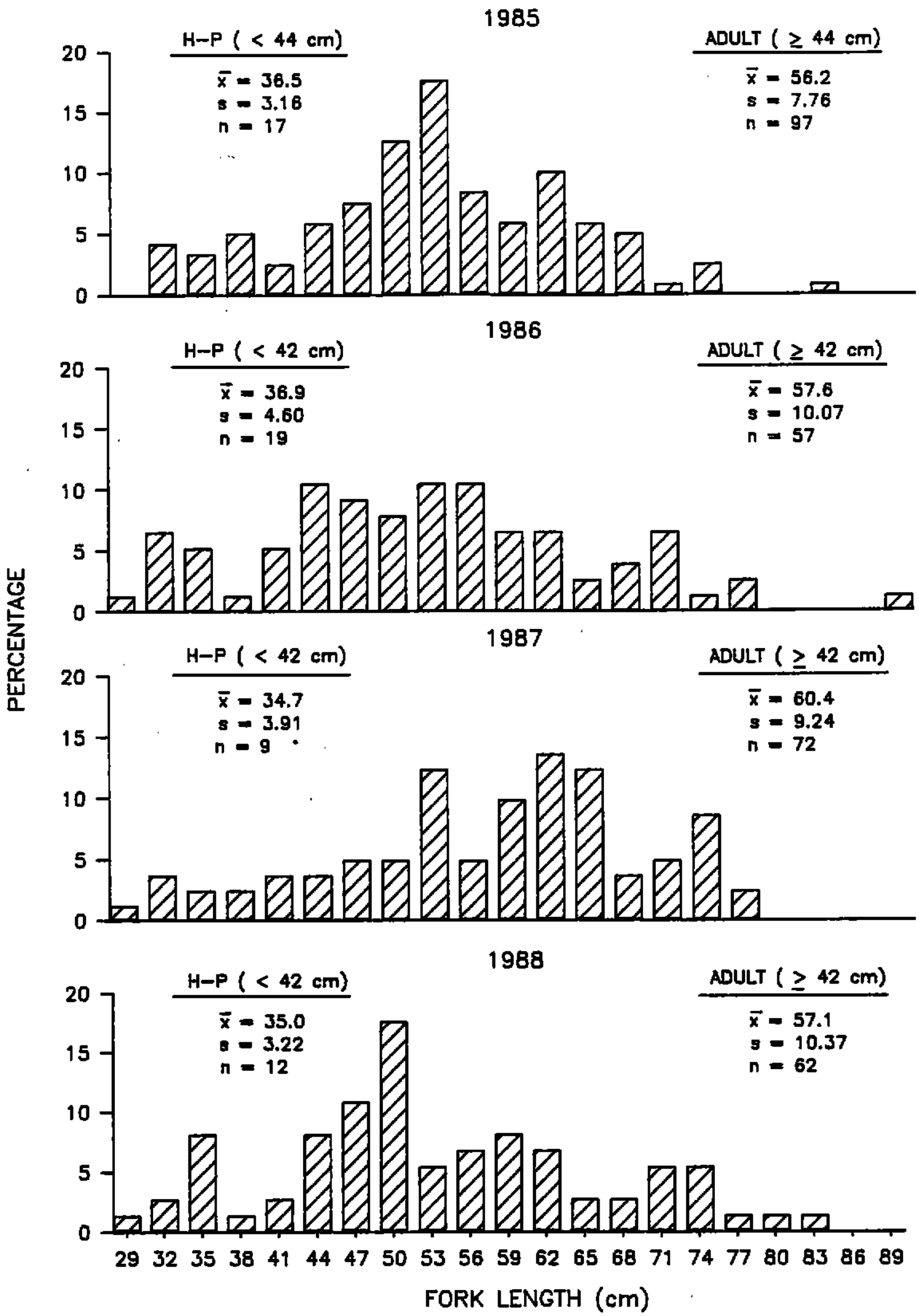

Figure 17. Length frequency distributions of fall steelhead trout harvested by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1985-1988.

TABLE 24. Final estimates of steelhead trout harvest by the gill net fishery on the Hoopa Valley Reservation during 1980-1988 1/.

	STEELHEAD TROUT		
Year	H-P	Adults	Total
1980	-	-	300
1981	181	535	716
1982	48	352	400
1983	23	340	363
1984	110	696	806
1985	46	457	503
1986	53	254	307
1987	30	347	377
1988	36	407	443

1/ Estimates for 1983-1988 Trinity River net fishery were obtained from the Hoopa Valley Council, Fisheries Department. All other harvest estimated by the Fish and Wildlife Service by methods described in previous annual reports.

TABLE 25. Estimates of green sturgeon harvest by the gill net fishery on the Klamath River portion of the Hoopa Valley Reservation in 1988.

Time Period	NET HARVEST MONITORING AREA Estuary	Middle Klamath	Upper Klamath	Semi-Monthly Total (All Areas)	Cumulative Seasonal Total
Spring	29	105	44	178	178
Jul. 1-15	15	0	0	15	193
Jul. 16-31	5	0	0	5	198
Aug. 1-15	7	0	0	7	205
Aug. 16-31	2	0	0	2	207
Sept. 1-15	0	0	5	5	212
Sept. 16-30	0	0	0	0	212
Oct. 1-15	0	0	0	0	212
Oct. 16-31	0	0	0	0	212
TOTAL	58	105	49	212	

majority of the green sturgeon (51.9%) harvest occurred in April during their spawning migration. The majority of the green sturgeon harvest (74.1%) in the Estuary Area occurred during June through August while the sturgeon were returning to the ocean.

Mean total length of adult green sturgeon, 178.8 cm, did not significantly differ ($p>0.05$) from mean lengths of adult green sturgeon harvested in 1985 through 1987 (Figure 18). Harvest estimates of green and white sturgeon for the Hoopa Valley Reservation from 1977 to 1988 are summarized in Table 26.

American Shad

Beach Seining

An estimated 1,431 American shad were captured. The first shad was captured on July 19 and the largest daily catch (1,000 estimated) occurred on August 9, 1988. By month, 29 shad were captured in July, 1,372 in August and 30 during September.

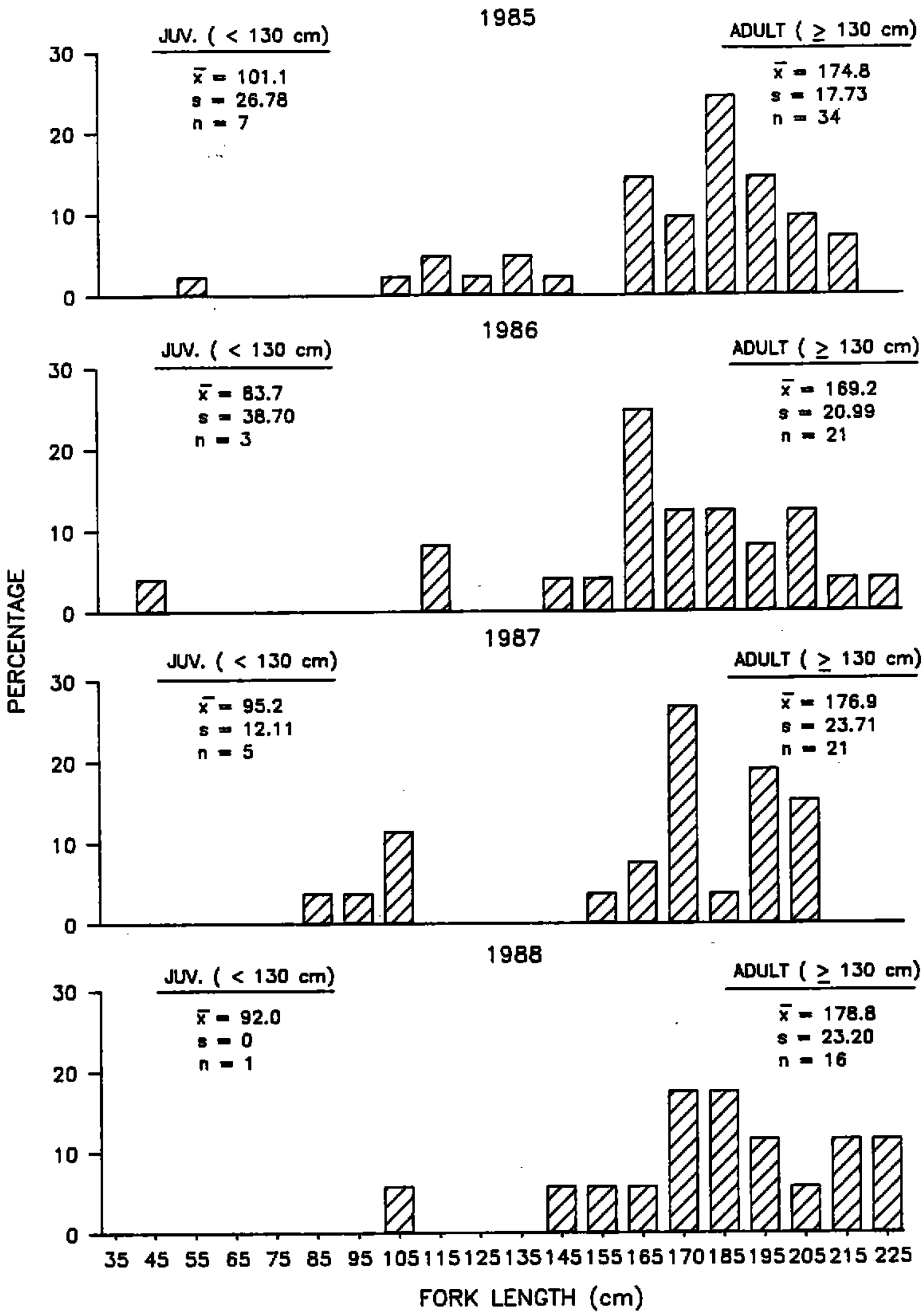

Figure 18. Length frequency distributions of green sturgeon harvested by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1985-1988.

TABLE 26. Final estimates of green and white sturgeon harvest by the gill net fishery on the Hoopa Valley Reservation during 1980-1988.[1/]

	WHITE			GREEN		
	JUV	ADULT	TOTAL	JUV	ADULT	TOTAL
1980	10	3	13	30	300	330
1981	10	5	15	25	810	835
1982	10	5	15	53	347	400
1983	10	0	10	89	406	495
1984	2	0	2	21	394	415
1985	2	1	3	31	330	361
1986	0	0	0	53	398	451
1987	0	0	0	33	158	191
1988	0	5	5	5	227	232

[1/] Estimates for 1983-1988 Trinity River net fishery were obtained from Hoopa Valley Business Council, Fisheries Department. All other harvest estimated by the Fish and Wildlife Service by methods described in previous annual reports.

PROGRAM PLANNING

INTRODUCTION

The goal of FAO-Arcata is to provide technical assistance and fishery expertise by conducting various specialized field programs which address specific problems as they are identified; while at the same time reserving the ability to conduct longer term monitoring programs such as are reported here.

The course of the Klamath River Fisheries Assessment Program, and the role of FAO-Arcata in addressing resource-related issues involving the Klamath River basin, evolved in response to Departmental direction through Memoranda of Agreement, the Critical Issues Management System, and the FWS Management By Objectives program. Further direction has been received through a Statement of Responsibilities and Role (FWS 1985b) of the Fishery Resources Program. The BIA planning processes involving fisheries resources of the HVR, continues to greatly influence program direction. Recently the passage of P.L. 98-541, the Trinity River Basin Fish and Wildlife Management Program, on October 24, 1984 and P.L. 99-552, the Klamath River Fish and Wildlife Restoration Act, on October 27, 1986, are exerting an influence on program direction with proposed fishery work scheduled to be initiated in 1988 and 1989.

PROGRAM PLANNING

Anadromous fishes of the Klamath-Trinity basin were identified as high priority and have been listed in order of preference for investment in restoration (FWS 1982). The Klamath River Fisheries Assessment Program will continue to focus on five of these stocks: fall chinook salmon, spring chinook salmon, fall steelhead trout, coho salmon and green sturgeon, which have been recognized as fitting the criteria of being depressed stocks, largely of natural origin, with high value to fisheries and good restoration potential.

For the priority species, FAO-Arcata programs will continue to center on: (1) collection of necessary baseline information on population characteristics, (2) monitoring of annual adult spawning migrations and juvenile populations, (3) monitoring of in-river net harvest levels and (4) analysis and presentation of information in a timely manner to those agencies responsible for managing this resource and (5) providing technical assistance to the Klamath River Salmon Management Council and Pacific Fisheries Management Council. FAO-Arcata programs will be conducted to the extent possible in cooperation with those of other agencies involved with the Klamath River fishery resource.

The Klamath River Fisheries Assessment Program was initiated through the FWS in 1977 at the request of the BIA in order to provide data necessary for management of the Klamath River fishery resource, in context of the expanding in-river net fishery. The FWS was selected for program initiation because of recognized expertise in fisheries management, there being no such capacity within the BIA or local Indian groups at that time. At such time as fisheries expertise is developed among local Indians, part or all of existing FAO-Arcata programs will be transferred to these groups. Such transfer of programs began with the establishment in 1981 of the HVBC, Fisheries Department. Former FAO-Arcata programs operating on the Trinity River under Memorandum of Agreement with the BIA have been entirely transferred to the HVBC. With this in mind, a major aspect of FAO-Arcata operations continues to be the training and education of local Native Americans in fisheries science. Specific directions anticipated for FAO-Arcata field activities in the near future are as follows:

(1) Beach Seining Operations need to be continued on a yearly basis. Primary emphasis will remain with fall chinook. FAO-Arcata beach seining operations currently provide the only available estimates of Klamath River fall chinook population age composition. Such data have proven useful in generating annual ocean stock size projections for use in fisheries management. The beach seining and harvest monitoring programs together provide two key interactive components of the Klamath River basin anadromous fisheries database. This database is used by the PFMC to assist in the management of the ocean fisheries and provides insight assessing the spawning escapement annually. Both programs need to be viewed as on-going monitoring programs to be continued indefinitely and not as baseline studies which will soon reach a point where necessary input has been supplied.

(2) Harvest Monitoring Operations provide the only presently available estimates of Indian gill net harvest of spring and fall chinook, coho, steelhead and sturgeon within the Klamath River portion of the HVR. This estimate is provided to the CDFG to assist in estimating the annual Klamath River run size. This estimate provides a view of the contiribution made by the Klamath stocks to the various fisheries and the spawning escapement. Collection of this critical information will continue. Research into data on size selectivity was incorporated into this program in FY87 with the funding of a three year study through BIA. Research into the relationship between net harvest and river flow models to predict net harvest and escapement associated with specific management options and other management-oriented aspects of the fishery should continue. Collection of a variety of baseline biological data from the net harvest will continue. Recoveries of coded-wire tags through monitoring of the net fishery is important to management of the fisheries and of hatchery stocks within the basin and will continue.

(3) Juvenile Chinook Salmon Production Monitoring was be initiated in the spring of 1988 to provide abundance indices of juvenile chinook salmon from the two major subbasins (upper Klamath and Trinity Rivers above Weitchpec). Such data will provide key information on production of hatchery and natural stocks in the basin; assist the management agencies in predicting year class strength at the juvenile stage; and assist in evaluating the restorations efforts under P.L. 98-541 and 99-552.

(4) Tributary Habitat Evaluation was initiated in the fall of 1988 on Blue Creek (a tributary to the lower Klamath River) and New river (a tributary to the lower Trinity River). These evaluations provide needed information for basin restoration as to whether restorations efforts should be directed toward these streams and if restoration is desirable then define how and where restoration should be directed.

(5) Technical Assistance was provided to the Department of Interior, Pacific Fisheries Management Council, Klamath River Salmon Management Council and Bureau of Indian Affairs on matters concerning Klamath River salmon management and Federal fisheries issues in Northern California. This assistance requires the melding of information collected by the field programs with data collected by other agencies into a comprehensive package useable for management. The need for this assistance will be ongoing.

Program planning, direction and coordination will remain essential and on-going parts of FAO-Arcata activities. Program coordination and information dissemination to other groups and agencies involved with the Klamath-Trinity basin fishery resource are recognized as high priorities. Frequent meetings will continue to be held with biologists representing the Bureau of Indian Affairs, Califoria Department of Fish and Game, U.S. Forest Service, Hoopa Valley Business Council, Oregon Department of Fish and Wildlife, National Marine Fisheries Service and other groups. Coordination with the Trinity River program under P.L. 98-541 and the Klamath River Restoration Act under P.L. 99-552 is essential. Such activities are crucial to the effective provision of fisheries assistance.

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